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ABSTRACT

In an investigation of the relationship of uric acid (a metabolic end product) to achievement, this study hypothesized that a person's serum urate level (a factor often associated with gout) is positively related to achievement need as well as indicators of actual achievement. (Speed of promotion and number of yearly publications were chosen as achievement criteria.) Interviews, test scores, and physiological measurements (including cholesterol readings) were used to collect data from 25 assistant, 25 associate, 46 full professors, and 18 academic administrators at the University of Michigan. Motivation was measured in a projective test involving storytelling, and through a rating scale. Although the exact psychological correlates of bodily processes involving uric acid still defy precise analysis, findings did confirm a relationship between achievement orientation (such traits as drive, self-confidence, and attitude toward pressure) and respondents' serum urate levels. High scholarly productivity was relatively dependent on personal drive, while speed of promotion depended more on decisions by others. Thus, it also appears, that different criteria of success prevail at different levels of the academic hierarchy. (LY)

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# RELATIONSHIP BETWEEN URIC ACID LEVEL AND ACHIEVEMENT MOTIVATION

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## TABLE OF CONTENTS

LIST OF TABLES ........................................ v-vii

LIST OF FIGURES ........................................ viii

ABSTRACT ........................................ ix-xi

I. INTRODUCTION AND REVIEW OF THE LITERATURE ................ 1-12

Purpose of the Study ........................................ 1

Review of the Literature ........................................ 1

Social and Psychological Correlates of Uric Acid Levels ..... 2

A historical note ........................................ 2

Serum urate levels and aspects of achievement .......... 3

Serum urate levels and stress ........................................ 8

Some Thoughts on Future Studies of Psychosocial Correlates of Uric Acid ........................................ 10

II. CONCEPTUAL FRAMEWORK AND HYPOTHESES ..................... 13-17

Conceptual Framework ........................................ 13

Discussion of the Variables ........................................ 13

1. Serum uric acid ........................................ 13

2. Serum cholesterol ........................................ 14

3. The need for achievement ........................................ 14

4. Actual achievement ........................................ 15

Formulation of New Hypotheses ........................................ 15

Other Relationships ........................................ 16

TABLE OF CONTENTS (cont.)

III. METHODOLOGY .................................................. 18-43

Introduction .................................................. 18

The Sample .................................................. 18

Source of the Data .................................................. 20

The Data Gathering Procedure .................................................. 21

Problems and Shortcomings .................................................. 23

The Variables and Their Measurements .................................................. 23

I. The physiological measurements .................................................. 23

A. Serum uric acid .................................................. 23

B. Serum cholesterol .................................................. 25

II. The measures of motivation and behavior .................................................. 26

A. The measures of motivation .................................................. 26

1. The Heckhausen test for achievement motivation .................................................. 26

2. The McClelland/Atkinson measure of need achievement .................................................. 31

B. Measures of achievement oriented behavior .... 32

C. Measure of work effort .................................................. 34

III. The achievement measures .................................................. 35

A. Rate of progression .................................................. 35

B. Scholarly productivity .................................................. 37

Relationship between the Motivational Indices and the Measures of Achievement .................................................. 39

Restatement of the Hypotheses .................................................. 42

IV. RESULTS .................................................. 44-54

Relationship between the Achievement Orientation Index, the Physiological Measures of Uric Acid and Cholesterol, and Actual Achievement .................................................. 44

TABLE OF CONTENTS (cont.)

Relationship between the Physiological Variables and the Various Tendencies of the Motivation to Achieve ......... 45

Relationship between the Physiological Variables and the Indices of Actual Achievement ......................... 47

Relationship between Actual Achievement and Work Load ....... 52

V. INTERPRETATIONS AND CONCLUSIONS ......................... 55-61

Interpretation ............................................. 55

Conclusions ................................................ 57

REFERENCES ................................................... 62-72

## LIST OF TABLES

Table Page

1 Mean serum urate levels and standard deviations for four groups of male subjects .... 3

2 Comparison of the status distribution of the eligible sample with the status distribution of the university as a whole .... 19

3 Age distribution of the various status groups in the eligible sample, and age distribution at the University of Michigan in 1961-1962 .... 19

4 Comparison of the refusals with those willing to participate on those variables where comparable information was available .... 20

5 Various sources of the data .... 20

6 Return rate of the data .... 21

7 Mean uric acid level distributed by status level in 1969 and in 1963 .... 24

8 Mean serum cholesterol level distributed by status group (expressed in mg/%) .... 25

9 Data on the reliability scoring for hope for success by two scorers .... 27

10 Data on the reliability scoring by two scorers of fear of failure .... 28

11 Correlation between motivation scores and length of protocol before and after correction for length of protocol .... 29

12 Distribution of total motivation scores among the different status groups (corrected for length of protocol) .... 29

13 Distribution of net hope scores (corrected for length of protocol) among different status groups .... 30

14 Distribution of hope for success scores (corrected for length of protocol) among different status groups .... 30

LIST OF TABLES (cont.)

Table | | Page
---|---|---
15 | Distribution of fear of failure scores (corrected for length of protocol) among different status groups | 31
16 | Distribution of the n. ach. scores among the different status groups corrected for length of protocol | 32
17 | Mean values of achievement orientation scores distributed by status level | 34
18 | Means and standard deviations for the number of hours worked in an average week in the various status groups | 34
19 | Intercorrelations among various ways of computing a rate of progression index for university professors | 36
20 | Means and standard deviations of the scores for rate of advancement in the various status groups | 36
21 | Intercorrelation among various ways of computing an index of productivity for university professors | 38
22 | Means and standard deviations of the productivity scores for the various status groups | 38
23 | Correlation between the various tendencies of achievement motivation and rate of occupational progress in the various status groups and the total sample of professors | 39
24 | Correlations between the various tendencies of achievement motivation and the amount of scholarly productivity in the various status groups and the total sample | 40
25 | Intercorrelation of the indicators of motivation and the indices of actual achievement | 40
26 | Means on rate of progression, productivity, and number of work hours for subgroups high and low on the motivational tendencies | 41
27 | Correlation between the achievement orientation rating, the physiological measures, and the indices of actual achievement | 44
28 | Correlation between uric acid level and subscores of the achievement orientation measures in this study and an earlier one | 45

LIST OF TABLES (cont.)

Table Page

29 Correlation between serum urate level and the various tendencies of achievement motivation in the various status groups and the total sample of professors ........ 46

30 Correlation between serum cholesterol level and the various tendencies of achievement motivation in the various status groups and the total sample ............. 47

31 Correlation between the physiological variables and the indices of actual achievement ...................... 48

32 Relationship between uric acid, cholesterol, rate of progression, productivity and age in the total sample and the various status groups .......................... 48

33 Correlation between the physiological variables and the indicators of actual achievement corrected for the influence of age ........................................ 49

34 Age-corrected correlation between the physiological variables and the indices of actual achievement in the tenured and non-tenured professors ..................... 50

35 Correlation between the indicators of actual achievement and the number of work hours in the total sample and the various status groups .......................... 52

36 Correlation between the indicators of actual achievement and the number of work hours in the total sample and the various status subgroups, each relationship corrected for the influence of the third variable on the relationship ......................................... 53

# LIST OF FIGURES

| Figure | | Page |
|---|---|---|
| 1 | Representation of the hypothesized relationship between serum urate levels, indices of achievement motivation and actual achievement ...................... | 13 |
| 2 | Correlogram illustrating the relationships between the variables cholesterol, age, and status. In each pair the first figure is the raw correlation while the second figure is the correlation partialling out the third variable .................................... | 26 |

# ABSTRACT

## SERUM URATE LEVEL AND ACHIEVEMENT MOTIVATION AMONG UNIVERSITY PROFESSORS

### Problem

This study investigates the relationship between uric acid, an end-product of purine metabolism, achievement motivation, and indicators of actual achievement. It is hypothesized that a person's serum urate level is positively associated with his need for achievement, and also positively associated with indicators of actual achievement.

### Method

One hundred thirty-one men undergoing the periodic health examination were contacted and asked to serve as subjects for our study. Seventeen refused. Those who refused had been three years longer with the university, on the average, than those who agreed to participate. No other differences between the two groups could be found. In age- and rank-distribution, the sample is representative of the total faculty at The University of Michigan. There is a good spread over the various departments and schools.

Data from interviews, test scores, and physiological measurements were collected from 25 assistant, 25 associate, 46 full professors, and from 18 academic administrators such as chairmen or deans.

Motivation was measured in two ways: (1) with the help of a projective test requiring story-telling, and (2) by way of an interview rating scale. We considered yearly number of publications, and speed of promotion as indicators of actual achievement, well knowing that in this area no single indicator will be completely satisfactory.

### Results

The major finding of the study is the confirmation of the relationship between our index of achievement orientation, rating such traits as drive, self-confidence, or attitude toward pressure, and the measure of serum urate level. The correlation between the two variables is $r = 0.50$ ($p < 0.01$).

One reason for using the story-telling test of achievement motivation was our attempt to specify more precisely the nature of the psychological correlate of serum urate level. We had hoped to show that it is the person's positive striving for success (in contrast to his attempts

to avoid failure) which is related to uric acid. Unfortunately, we could not substantiate this. The correlation between serum urate level and the test score supposedly indicating success striving is r = 0.03. This lack of relationship might be explained by the fact that we have reason to believe that some professors told stories indicative not of their motivation to achieve success but illustrating their concern over not having achieved enough.

The two criteria of actual achievement, scholarly productivity and rate of promotion, differ in the degree to which the professor himself has control over them. To reach a high level of productivity is, relatively speaking, more dependent on personal drive, and more of a personal achievement than is one's rate of promotion. Thus, we are not too upset to find no relationship between uric acid and rate of promotion, especially since the man's rate of productivity is related to his serum urate level, although differentially at the various status levels. Among the non-tenured faculty (assistant professors) the correlation is positive ($r = 0.37$, $p < 0.10$). This relationship is significantly reversed in the tenured faculty ($r = -0.31$, $p < 0.05$). We interpret this finding as indicating that the production of scholarly papers is considered a criterion of success at the non-tenure level, but has a changed meaning for those at the tenure level.

It seems that this suggestion that different criteria of success prevail at different levels of the academic hierarchy is supported by the relationships of the indicators of actual achievement to each other and to the number of hours a man works during the average week.

Summarizing our interpretation of these relationships we might say: A young Ph.D. is hired because of his "promise," and not because of either hard work or productivity. To become associate professor, however, he has to fulfill that promise by demonstrating scholarly productivity. Having demonstrated it, having passed the screening, so to speak, the effective criteria of promotion may change for some away from scholarly productivity to other ends that can be accomplished by hard work. We have no data on what these other pursuits might be but suggest that consulting, work in national organizations, or, in general, work that provides visibility in the field beyond the range of one's work peers might be the kind of work effort that pays off for the man who has passed the scholarship test by having been made an associate professor. It needs to be pointed out, however, that this interpretation holds true only if we separate the academic administrators, who are themselves virtually all full professors, from the rest of the full professors, since the academic administrators seem to be a group whose speed of promotion up to the full professor level seems to have depended on productivity, and who seem to be concerned, as were the associate professors, with using their work effort toward increased productivity.

## Conclusions

There remains very little room for doubt in the finding that there does exist a relationship between uric acid level and the "psyche," as one editorial puts it. On the other hand, the exact psychological correlate of bodily processes involving uric acid still defies precise definition.

We suggest that instead of continuing correlational studies trying to link a biochemical substance, uric acid, to a trait like achievement motivation that is greatly influenced by socialization, experimental research should be undertaken raising and lowering uric acid levels, and observing the effects of these manipulations on the functioning of the central nervous system. We now entertain the hypothesis that raising a person's serum urate level might lead to a higher level of central nervous system activity and that this activity will be channeled into those areas of life the person values highly. We fear, however, that this kind of research is beyond the scope of the Institute for Social Research and will have to be carried out by a medical team.

# CHAPTER I

# INTRODUCTION AND REVIEW OF THE LITERATURE

## Purpose of the Study

The purpose of this research is to study the relationship between achievement motivation and serum uric acid, a biochemical variable in its molecular structure similar to the cortical stimulants caffeine and theobromine. According to some researchers (Orowan, 1955; Pfeiffer & Iliev, 1967), uric acid itself is an agent that arouses central nervous system activity.

The present study builds on our earlier studies of university professors (Brooks & Mueller, 1966), high school students (Kasl et al., 1966), and men losing their jobs (Kasl et al., 1968) in ways that will be discussed in greater detail later.

In the following, we will first give a review of the literature, then state our conceptual framework and the hypotheses before going on to a discussion of the methodology.

## Review of the Literature

A number of recent developments and findings involving uric acid have made this substance worthy of the attention of psychologists whose work or interests encompass physiological and medical variables. One such development is the report of a strikingly strong relationship between uric acid levels and the personal characteristics of drive, achievement, and leadership among university professors (Brooks & Mueller, 1966). This, and other findings to be examined in this review, give substance to an earlier editorial in the Journal of the American Medical Association, hypothesizing that high serum uric acid levels are "related to behavioral characteristics that lead to outstanding performance and therefore to upward social mobility or to the maintenance of high social status achieved by one's forefathers [Anonymous, 1963]." These developments are fully consistent with the frequent observations, made over several centuries, that the metabolic disease known as gout is associated with a higher level of eminence (e.g., Copeman, 1964; Rodnan, 1961), since the probability of an acute attack of gout and/or the formations of a sodium urate kidney stone is a direct function of the level of uric acid in the blood (Cobb, 1969).

The review focuses on psychological and social correlates of uric acid, emphasizing variables related to achievement behavior. The review will close with some considerations of directions for future research.

# Social and Psychological Correlates of Uric Acid Levels

## A Historical Note

Gout has been considered since antiquity the obulus paid for sacrificing at the altars of Venus and Bacchus, that is, the result of intemperance and venery, since Podagra, the foot-torturess, was believed to be have been born of the seduction of Aphrodite by Dionysus (Rodnan, 1965a, 1965b). But since such overindulgence required a certain amount of wealth, at least in antiquity, gout also became known as a disease of the upper classes, in fact, somewhat of a status symbol (Bell & Stokes, 1848). Already in the seventeenth century, Thomas Sydenham, the famous physician suffering from gout, consoled himself by observing: "In this manner have lived, and in this manner finally died, majestic Kings, Rulers, Generals, Philosophers, and Admirals, and many others of rank [Kobler, 1962, p. 87]." With so many of the mighty of this earth suffering from the disease, it was believed that gout had an affinity for persons of outstanding achievement. Gout is said to have driven the Roman general Agrippa to suicide; it made Henry VI change the date of his marriage to Margaret of Anjou; and it soured Martin Luther's disposition. The line stretches from Alexander the Great, Charlemagne, Kubla Khan, Frederic II to Charles Darwin, and Bernard Baruch. The association between gout and superior attainment became evidently quite accepted by the time Havelock Ellis wrote

> There is a pathological condition which occurs so often, in such extreme forms, in men of preeminent intellectual ability, that it is impossible not to regard it as having a real association with such ability. I refer to gout . . . . The genius of the gouty group is emphatically masculine, profoundly original [Ellis, 1904, p. 83].

Once it was determined that persons with gout have elevated serum uric acid levels, it became only a matter of time before someone put forward the hypothesis that high uric acid and superior attainment may also be associated. And we have already seen how in 1955 Orowan offered the theory that uric acid may be an endogenous cortical stimulant, and cast this theory into an evolutionary framework. Somewhat critical of Orowan's speculation, Haldane (1955) proposed two testable hypotheses: (a) If it is true that uric acid acts as a cortical stimulant, then persons with high uric acid levels should be more intelligent, and (b) such persons should be, moreover, less susceptible to certain kinds of fatigue. It is difficult to see why the first hypothesis should be a reasonable deduction from Orowan's theory. A cortical stimulant can have all kinds of effects without altering intelligent behavior. Nevertheless, the hypothesis was put to the test in 1959 when Stetten and Hearon reported a significant positive correlation between serum urate level and intelligence, as measured by the Otis test in a group of 817 army recruits. However, the correlation ($r = 0.08$), while significant, accounts for too little of the variance to make this a meaningful relationship. A similarly small correlation ($r = 0.10$) between the Otis test and serum uric acid was obtained when the Dunn et al. (1963) data on high school boys were further analyzed. Among medical students, no association was found between the Medical College Aptitude Test (MCAT) and serum urate levels (Dunn et al., 1963). It may be concluded that Haldane's hypothesized relationship between intelligence and serum uric acid is too weakly supported to constitute a promising line for further research. Since the hypothesis was not a clean-cut deduction to start with, this seems of little consequence. Haldane's second hypothesis concerning the susceptibility to fatigue still awaits testing.

## Serum Urate Levels and Aspects of Achievement

A different approach to the question of correlates of uric acid is represented by the work of Dunn et al. (1963); for preliminary reports on this study, see also Cobb, Dunn, Brooks, and Rodnan (1961) and Cobb (1963).

In the study by Dunn et al., the emphasis is not on intelligence but on some rather general indicators of achievement, prominently among them social class. Starting with the lead provided by all the time-honored clinical observations that gout is "a disease of the best constitution" (Cadogan, 1772) and is found among persons of outstanding achievement, Dunn et al. determined the serum urate levels, using the enzymatic method (Liddle, Seegmiller, & Laster, 1959), on several groups of male subjects: executives and craftsmen from several companies, Ph.D. scientists from Oak Ridge, medical students, and high school students. The means and standard deviations for five of these groups are given in Table 1.

TABLE 1

MEAN SERUM URATE LEVELS AND STANDARD DEVIATIONS
FOR FOUR GROUPS OF MALE SUBJECTS

| Subject | N | Mean | Standard deviation |
|---|---|---|---|
| Craftsmen | 523 | 4.77 | 1.13 |
| Ph.D. scientists | 76 | 5.34 | 1.23 |
| Medical students | 96 | 5.44 | 1.13 |
| Executives | 339 | 5.73 | 1.21 |

Note.--Taken from Dunn et al., 1963.

On the basis of their data, Dunn et al. concluded that a social class gradient in uric acid levels does indeed exist. The difference between the Ph.D. scientists and the executives, if replicable, would suggest that something more than just the variable of occupational status is involved; perhaps variables reflecting self-selection into different occupations and/or variables reflecting the work environment are also at play.

Dunn et al. carried out additional analyses that yielded interesting results which proved stimulating for later research. High school boys with high serum urate levels (a) participated in more extracurricular activities, particularly those of the nonathletic variety (since the boys who joined only athletics were no different on serum urate from those who participated in no activities whatsoever, one cannot argue that the higher serum urate levels were simply an outcome of vigorous exercise among athletes); and (b) received more service awards and were rated by teachers higher on industry, leadership, and responsibility. The association with grades was neither strong nor linear, but the A students did have the highest serum urate levels. Uric acid was not associated with parental education, father's occupation, or the subjects' occupational preferences, thus ruling out an explanation via social class of origin. Among the medical students, no association was found between serum urate and either grades or the discrepancy between grades and the Medical College Aptitude Test (i.e., an indication of over-underachievement). Later analyses (Kasl et al., 1966) revealed that over-underachievement in high school boys is also unrelated to uric acid. Among the craftsmen, a weak association was found between the number of years of education and uric acid.

Supporting findings appear in a preliminary report from the Tecumseh Community Health Study (Dodge & Mikkelsen, 1964). Working with age-sex corrected serum urate values, they found high levels among men in professional and executive jobs and low levels among farmers and those in unskilled jobs. When the serum urate scores were then examined in 1,500 spouse pairs, the social class gradient prevalent among the husbands was not reflected in the values of the wives, which would seem to indicate that the differences found among the men should not be attributed to class-specific living styles, such as dietary habits, which the wives can be expected to share.

Highly interesting data are reported by Montoye et al. (1967) on a group of 167 executives aged 30 to 59 years, who came from all over the country to enroll in the University of Michigan School of Business Administration Summer Executive Development Program. The mean serum uric acid level of these executives was higher than for Tecumseh men in general in the same age range, and this difference was larger than the difference obtained when comparing the Tecumseh professionals and executives with the rest of the male population in that town (Dodge & Mikkelsen, 1964). Thus, if participation in such an Executive Development Program is an indication of strong ambitions, then it would appear that the more ambitious executives have higher uric acid levels than unselected executives from a small community.

Of the additional analyses performed by Montoye et al. (1967) the most interesting one relates to amount of physical activity: The more physically active excutives had higher uric acid levels. Since almost all have sedentary jobs, activity here reflects leisure-time activities, and the finding is similar to the observed positive association between uric acid and extracurricular activities among high school boys (Dunn et al., 1963). In the general Tecumseh male population of the same age range, and in the group of state employees studied by Lanese and co-workers (1969), no such association between activity level and uric acid was found.

In other respects, however, the group studied by Lanese and co-workers resembles more the executive studies by Montoye et al. (1967) than the general Tecumseh population. With an average of three years of college and predominantly white collar occupations they are clearly better educated and of higher occupational status than the comparable Tecumseh population. Since the serum urate level of the state employees is significantly greater than the corresponding values found by Mikkelsen et al. (1965), the authors interpret their findings as supporting the notion of a social class gradient and conclude: "While further support for the social class-hyperuricemia association is hardly necessary, it is here again observed [Lanese et al., 1969, p. 1881]."

Additional evidence for a social class gradient comes from Great Britain: Anumonye et al. (1969) reported a mean uric acid value of 6.00 mg/100 m. (± 0.88) for 100 Edinburgh executives, as compared with a mean of 4.50 mg/100 ml (± 0.80) for 40 randomly selected controls. Comparisons across studies using the uricase method also yielded supportive evidence: The Caucasian control group of 88 prison inmates in Decker, Lane, and Reynolds (1962) had a mean of 5.0 mg/100 ml (± 1.10), while 113 university professors in Brooks and Mueller (1966) had a mean of 5.66 mg/100 ml (± 1.17). A social class gradient has even been reported for mental patients (Gerard, 1964). There are three studies, however, which fail to find an association between uric acid and socio-economic status (Acheson & O'Brien, 1966, 1968; Mersy, Auyong, & Eelkema, 1968; Popert & Hewitt, 1962), even though two of these studies (Acheson & O'Brien, 1968; Popert & Hewitt, 1962), did report a social class gradient for gout. The Popert and Hewitt study did not give mean uric acid levels for each of their five social classes; rather 24 of their 461 male subjects (5.2%) were designated as hyperuricemic (above 6.0 mg/100 ml) and the distribution of only these 24 men by social class was given. For our purposes, this is clearly such an insensitive way of detecting overall differences in means, that these findings cannot be regarded as very conclusive. The Acheson and O'Brien findings, on the other hand, are clear enough: No social class gradient is evident in the mean uric acid levels. There is no ready explanation why this study is not in agreement with the other ones reviewed above. It is worth noting, however, that their subjects were volunteer blood donors, not a probability sample of New Haven inhabitants, and that the obtained mean uric acid levels are considerably higher than those reported in other studies. The findings by Mersy and co-workers are difficult to interpret since there is no ready way to translate the values, obtained with small samples and by a not widely used method, into comparable uricase levels.

The suggestions made in the study by Dunn et al. (1963) have since been taken up, and a number of studies have investigated the possible relationship between serum uric acid, achievement, and achievement motivation. In a study of university professors, Brooks and Mueller

(1966) coded from lengthy, semi-structured interviews the following characteristics which lead to outstanding performance: drive, perceived achievement, leadership, pushing of self, range of activities, attitude towards pressure, and emphasis on research. Because of moderate intercorrelations among these, the ratings were summed into a Total Achievement Orientation Behavior Score. The estimated coding reliability of this total score was over .90. On a cross-validated sample of 51 professors, a correlation of 0.66 was obtained between the total score and serum uric acid levels. All of the individual subscales except two (attitude towards pressure and emphasis on research) also showed strong associations with uric acid. Since the correlations of the total score with such variables as obesity, alcohol and coffee consumption, smoking, hours of sleep, and so on, were quite negligible these variables do not readily lend themselves to alternative explanations of the main finding.

Recently, however, Lanese et al. (1969) have shown that, among hyperuricemic state employees, job stability is lower, and perception of change in one's life situation is greater than in a nonhyperuricemic comparison group. This evidence leads the authors to ask whether "the associations of 'drive' and 'achievement' with hyperuricemia . . . may reflect a changed way of life for people with greater upward mobility rather than an inborn physiologic difference in such individuals [Lanese et al., 1969, p. 1881]."

The Brooks and Mueller (1966) findings may have limited replicability in the sense that (a) the measures were tailor-made to the particular subjects, and (b) the relationships may hold only such unique work settings as a large university. Nevertheless, the replication conducted by Anumonye et al. (1969) on 100 Scotish executives, using as much as possible the same assessment procedures, in general confirmed the findings on the professors, but the relationships were weaker. Jenkins and Hames studying 174 male managers and full-time employees in a supermarket chain in Georgia, and correlating serum urate levels with the scores on a self-report measure of Rosenman and Friedman's (1963) "coronary-prone behavior pattern," found uric acid values correlated with those items of the test indicating drive, competitiveness, and challenging life circumstances. On the other hand, Sales (1969) who developed a self-report questionnaire measure for many of the dimensions studied by Brooks and Mueller (1966) and Jenkins and Hames (1967) found generally insignificant correlations with uric acid. But since his subjects were college sophomores who had not yet entered an occupation, it is doubtful whether his measures had the same meaning for them as for persons coping with the problems of everyday work situations. That even within college different achievement situations are differentially related to uric acid levels was suggested by Gordon, Lindeman, and Gordon's (1967) finding of a significant correlation between serum urate levels and college achievement during the clinical years of a nursing student (junior and senior years), but lack of such a relationship in the earlier "academic" years (freshman and sophomore years).

The relation of uric acid values to educational achievements was further investigated by Kasl et al. (1966) in their study of the educational career of the high school students previously seen by Dunn et al. (1963). The results offer additional evidence for the relationship of uric acid to aspects of achievement-oriented behavior. The serum urate levels of 62 male junior and senior high school students were determined in 1961 and again 4-1/2 years later. The subjects were divided into three groups: (a) those who completed college, (b) those who attempted college, but eventually dropped out, and (c) those who did not attend college at all. With regard to high school grades,the dropouts and those who never attempted college were alike and both were expectedly lower than those who completed college. However, with regard to uric acid levels, those who at least attempted college showed the highest levels, suggesting that what differentiated them from those who never attended college was not a difference in grades or ability, but in motivation to obtain further education. Consistent with this interpretation, it was found that within the attempted college group, the longer they attended college before dropping out, the higher their uric acid levels. Moreover, within the group of those who completed college, those with poor grades had the highest uric acid levels, a finding which suggests that these students with poor ability but high uric acid have sufficiently high motivation to complete college, while students with poor ability and low uric acid levels quit sooner or never attempt college. It is also worth noting that the uric acid levels had been determined while the subjects were still in high school, indicating a true predictor of college attendance--a predictor in the temporal sense, if not in the causal sense. Moreover, the amount of change in uric acid levels between the first and the second determination was unrelated to college attendance, thus weakening the hypothesis that elevated levels are simply a consequence of increased effort.

A partial replication of these findings comes from still unpublished data on the reeducation of the culturally deprived school dropout. Serum urate determinations were made on a subsample of 45 male students in a job training course. These subjects were divided into three groups: (a) Those who graduated from the program and were placed in a job, (b) those who graduated but were not placed, and (c) those who dropped out of the program. Those who were not placed and those who dropped out of the program were comparable on ability, both groups being lower than those who graduated from the program and were placed. On uric acid levels, however, those who graduated but were not placed showed the highest levels. The parallel with the high school data is, indeed, striking. Also supported was the prediction that these 45 school dropouts would have a mean uric acid level lower than the norms for males in comparable age groups.

These are interesting findings which clearly require replication. It must be pointed out that much will depend on the school setting in which such future studies are carried out. For example, in a university which has only students of uniformly high ability, grades might show a positive association with uric acid and dropping out might be more common among those with low uric acid levels.

Attempts have also been made to relate uric acid levels to birth order. The hypothesis here is that firstborn persons will have higher serum urate levels, inasmuch as many studies and reviews (e.g., Altus, 1966; Cobb & French, 1966; Sampson, 1962; Schachter, 1963) have suggested that firstborn tend to have a higher need for achievement and are more likely to obtain more education. Evidence supporting this hypothesis has been doubtful so far. Kasl et al. (1966) found in the group of 62 high school students higher uric acid levels among the firstborn, but this relationship was not significant in the original group of 138 students (Dunn et al., 1963). Gordon and Gordon (1968) did find an association among nursing students. However, it is not that the first-born stand out as higher on uric acid; rather it is that the uric acid of the last born is lower.

The studies which we have reviewed in this section have utilized some behavioral indicators of actual achievement or self-report measures of achievement-related traits. Demonstrated relationships between uric acid and more directly measured intervening motivational states (i.e., the need for achievement) are still lacking. Raynor (1967) attempted to score the interviews with the professors of the Brooks and Mueller (1966) study for need achievement, need power, and need affiliation by adapting the McClelland, Atkinson et al. (1958) picture-scoring system to interview questions. While there was no relationship found between need achievement scores and uric acid levels, there was some suggestion that those high on need achievement and need power showed higher levels of uric acid. However, the evidence was, at best, suggestive. Data collected by Mueller (1968), though also preliminary, yielded somewhat stronger findings. Comparing a group of 30 gout patients (with an average uric acid level of 8.48 mg/100 ml) with a control group of students in social work on a test for need for achievement which differentiates between the two basic motivational tendencies, "hope for success" and "fear of failure" (Heckhausen, 1963) it was found that the gouty persons with elevated uric acid levels had significantly higher scores for hope for success and significantly lower scores for fear of failure. This suggested relationship--that gouty subjects with known hyperuricemia are different on need for achievement from controls presumed to have normal uric acid levels--clearly needs to be followed up on subjects unselected with regard to gout and under better controlled conditions.

It would seem worthwhile to emphasize to the reader that this cumulative evidence on uric acid and aspects of achievement involves male subjects only. In the Dunn et al. (1963) study, data on high school girls were also available, but no significant association between the number of extracurricular activities and uric acid levels was found (not reported in the original article). The one study which is on women (nursing students) did report a positive association between uric acid and extracurricular activities (Gordon et al., 1967). Since women have obviously been neglected in these studies, it is too early to speculate about the possibility that the relationship of uric acid to achievement may be established only among men. This neglect of women in achievement motivation studies is not new (e.g., Atkinson, 1958; Atkinson & Feather, 1966).

## Serum Urate Levels and Stress

The studies reviewed in the previous section have implicitly assumed that a person's serum urate level is a relatively stable characteristic. Investigations concerned with changes in urate levels have generally dealt with brief periods of time, as in studies of diurnal variation, diet, alcohol, drugs, and exercise, and little is known about changes over longer periods of time. Moreover, one can argue that, provided the environment and the person's life style remain constant, the assumption of stability of uric acid levels is not a bad one. Recently, however, there have appeared three publications which suggest that large amounts of psychological or social "stress" can have profound effects on serum urate levels. (The term "stress" is, of course, not a clearly defined concept and refers to nothing more than the environmental situations studied in the following investigations.)

Rahe and his co-workers (Rahe & Arthur, 1967; Rahe, Rubin, Arthur, & Clark, 1968) followed,up to four months, Navy men who were undergoing underwater demolition training. The fluctuations in uric acid levels observed in this study over the four months were certainly larger than anything previously noted (or even anticipated) on healthy men. Some of the fluctuation can undoubtedly be attributed to the strenuous physical effort required during certain stages of the training. Beyond this, there was a striking "anticipation" effect: The first determination done on blood samples collected prior to start of training, yielded clearly elevated uric acid levels, as high as at any other time during training. Other fluctuations in urate levels are described by the authors as follows: (a) Significant increases in serum uric acid occurred when the trainees were approaching arduous activities with an optimistic attitude and determination to succeed, that is, during periods of anticipating a demanding situation; and (b) on the other hand, serum urate concentrations showed a significant fall during a period of quite intense psychological exhaustion when the men felt overburdened by the demands made upon them and felt no longer assured of success. Unfortunately, inferences about the perceptions and psychological reactions of the men were not made from self-reports, nor from independent observations of individual men. Rather, they were inferred from the type of training activities going on and from generalized observations of the trainers. The reader is thus unable to check for himself the extent to which the data do fit the authors' description. Of course, the significant rise of uric acid level just prior to the start of the training, interpreted as an anticipation effect, is not vulnerable to this criticism.

In a study of men undergoing job loss (Kasl et al., 1968), stably employed blue collar workers were followed up to two years as they went through the experience of losing their jobs because of a permanent plant shutdown. Anticipation of job loss (i.e., during the period when the men were still on their old jobs but knew of the impending plant shutdown) was associated with elevated uric acid levels. Uric acid levels dropped sharply to normal if the men found quick reemployment; otherwise, they remained high till the men were on a new job before showing the same drop. Larger drops in uric acid between anticipation and reemployment were seen in men reporting more severe but brief stress. An interesting side finding was that the men who resigned their jobs early instead of waiting for company scheduled termination had stably high uric acid levels. If such early resignation indicates greater initiative, drive, and active matery over the environment, then this finding is consistent with results of studies reviewed in the previous section of this review.

In both the above studies, of the frogmen and of the men losing their jobs, changes in cholesterol levels were also observed. No anticipation effects were evident and the patterns of cholesterol fluctuations were different from those observed for uric acid. Interviewer's ratings of depression were correlated differently with uric acid than with cholesterol (Kasl et al., 1968). Clearly, then, much more needs to be learned about the circumstances in which uric acid, or cholesterol, or both will go up. And the fact that medical students just before examinations show elevated cholesterol but not uric acid levels (Dreyfuss & Czaczkes, 1959) suggests that different types of anticipation have different effects.

## Some Thoughts on Future Studies of Psychosocial Correlates of Uric Acid

The purpose of this review is not to convince the reader that a certain set of conclusions can be compellingly drawn from the studies examined. Nor was it the intention of the authors to report on a body of evidence which is essentially complete. Instead, we intended to familiarize the interested reader with a set of ideas and findings which are still very much in flux and turmoil. Accordingly, this review will be concluded with a brief consideration of some of the work which needs to be done next.

Clearly, the first question which needs to be raised is: What aspects of achievement (broadly defined) are related to uric acid, in what kinds of populations, under what kinds of circumstances? The only way to deal with this question is via an accumulation of correlational studies on diverse populations, in diverse settings, and using diverse measures. Because of the expense and inconvenience involved in collecting blood, many such studies will be opportunistic rather than elegant, random samples of clearly specified populations. Insurance salesmen and brokers, foremen, high school teachers, college students, mental retardates, women in general, are some of the neglected groups which come to mind. With regard to measures of achievement, multiple operationism is clearly called for: Diverse behavioral indicators, personality correlates, self-ratings and ratings by others should be considered. The important point is that in each setting the investigator must determine what are the achievement indicators most appropriate for the given situation, since what represents achievement for a college professor may vary greatly from those indicators that signal achievement to an executive or blue collar worker.

Furthermore, work is needed to determine whether the relationship between uric acid and achievement can be explained by the intermediary effect of serum urate levels on achievement motivation, although other hypotheses are conceivable. Again, the use of more than one assessment procedure is called for until we know more (e.g., TAT-type tests for need achievement, Test Anxiety, Achievement Risk Preference Scale, risk taking, task persistence, etc.)

The authors also feel that some of the correlational studies of uric acid should involve laboratory behavioral tasks, particularly those used by psychologists like Cattell (1957) in their attempts to map the domain of personality, for example, reaction time, flicker fusion speed, attention span, immediate memory, motor persistence, skin resistance, field independence, etc. There is a temptation to speculate that factors like Cattell's (1957) corticalertia, "alert, eager, controlled contact with external events," will show a relationship to uric acid.

Beyond these suggested correlational studies, investigations of changes in uric acid levels are also needed. Longitudinal studies of naturally occurring changes in the environment, particularly those which are "stressful," are clearly one such type. Special attention needs to be paid to the distinction between objective and perceived environment, to the role of stable personality variables which might condition the effects of the environment, and to the concomitant changes taking place at the affective level. Only in this way can we hope to begin to understand such changes in uric acid levels as those due to "anticipation."

In the long run, the evaluation of static relationships will be inadequate and dynamic, that is, longitudinal, studies must be undertaken. First, we need to know how quickly uric acid levels change and how long the changes last. Second, we must find out if these changes are largely produced by changes in renal excretion rates or by other mechanisms. These matters can well be studied by manipulation of the environment of persons under continuous observation from whom periodic blood and urine samples are obtained.

By the same token, studies manipulating the uric acid levels by feeding of nucleoproteins or purines and by the use of drugs inhibiting production from xanthine and drugs promoting urinary excretion are both safe and feasible. However, serum levels above 9 mg/100 ml should not be maintained for long because at that level the risk of acute gout and renal stones is too great (Cobb, 1969). It is reasonable to suppose that the effects on such variables as reaction time and flicker fusion frequency would be quite prompt while effects on memory, even if they exist, might take a little longer, and a change in achievement-oriented behavior might occur only after a number of months. The appropriate assessment of the proper interval for measurement will be crucial in such studies. On the whole, studies like these should be carried out on normal individuals who have the maximal range of responses. However, the idea that there might be a subset of the feebleminded who would benefit substantially from having their serum urate levels raised is worthy of exploration, although this clearly does not apply to such groups as Mongolian idiots, microcephalics, those with specific brain damage, and those with recognized genetic deficiency such as phenylketonuria since uric acid could not possibly have any effect on them.

The goal of the work should be to better understand and possibly to decide between three alternatives for understanding the observed relationships: (a) Uric acid is a causal influence on motivation and/or behavior;

(b) environmental stimulation influences a person's motivation and/or behavior which, in turn, affects the serum urate level; (c) environmental stimulation affects both, the person's serum urate level, and his motivation and/or behavior, without causal links between the two.

It goes without saying that a complete program of research in this area would include basic work on the metabolism of uric acid. However, the authors do not feel competent to offer any recommendations in this direction, nor do they feel that such recommendations would fall properly within the scope of this review.

# CHAPTER II

# CONCEPTUAL FRAMEWORK AND HYPOTHESES

## Conceptual Framework

The hypothesized relationships among the variables, described below, is probably best made clear by the following diagram. The arrow represents presumed causal relationships. Such a diagram is not meant to exhaust all the existing logical possibilities for relationships but rather to illustrate our present thinking about the nature of the variables.

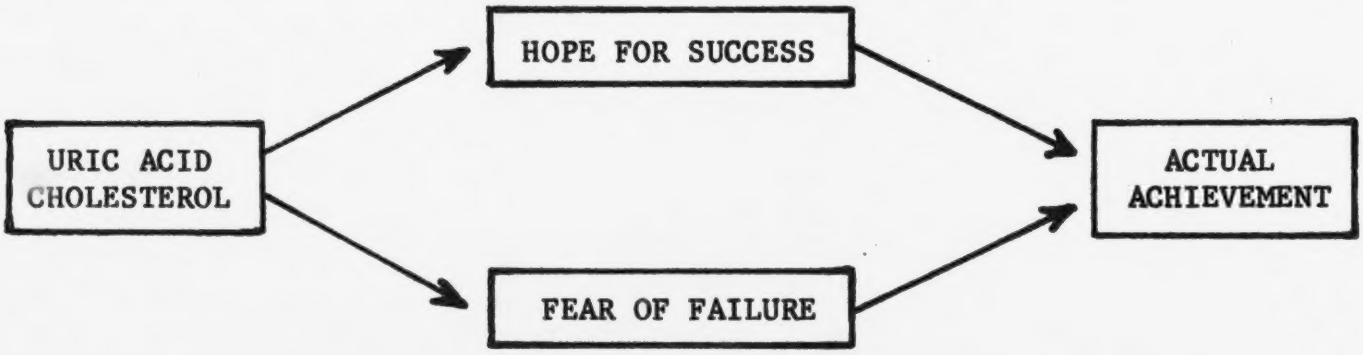

Figure 1. Representation of the hypothesized relationship between serum urate levels, indices of achievement motivation and actual achievement.

## Discussion of the Variables

### 1. Serum Uric Acid

Uric acid is the major end product of purine metabolism in humans. It is primarily derived from the catabolism of nucleic acids set free by the breakdown of body cells and digestion of animal foods. In addition, there is some de novo biosynthesis in the body. The last step of the catabolic pathway goes through xanthine to uric acid. Both of these substances are chemically related to caffeine and theobromine, the stimulants found in coffee and tea. In the long run, it will be necessary to measure these substances separately. But, since their levels are presumably related by the law of mass action, in this phase of our research we will measure uric acid.

Uric acid levels in the serum increase with age up to about the end of puberty and then level off at about 5.2 mg/100 ml in males and about 4.2 mg/100 ml in females (Mikkelsen et al., 1965). Serum urate levels are quite stable over time, test-retest correlations even over long periods run above r = 0.70, though large variations may occur in relation to stressful environmental circumstances such as losing one's job (Kasl et al., 1968) or training in underwater demolition (Rahe & Arthur, 1967).

## 2. Serum Cholesterol

Serum cholesterol can be described as a waxy substance of the sterol group that is taken in with the diet or synthesized by the body. It is to some extent present in all cells of the body, but has its highest concentration in the brain and the adrenal cortex. Cholesterol is to some extent contained in all ordinary diets. Moreover, the body can synthesize cholesterol from any dietary source providing acetate. Cholesterol plays a major role in the pathogenesis of atherosclerosis because it is a substance that can accumulate in the walls of the arteries and produce an obstruction. Moses (1963) states that "it is generally accepted that from one-half to three-quarters of the dietary cholesterol is absorbed [into the blood stream]. [1963, p. 92]"

Moses (1963)--citing Gould (1954)--says that cholesterol is extracted from the blood by the liver, particularly by converting it into bile acids. From 70 to 90% of the cholesterol degradation involves the formation of bile acids. However, he also points out that the evidence on this point is not absolutely clear.

Cholesterol is of interest to this study because there is an increasing body of literature which links serum cholesterol levels to situational stress and psychological strain. The literature on this point is reviewed by Moses (1963) and by Kasl and French (1962).

## 3. The Need for Achievement

According to the value-expectancy theory of motivation (McClelland et al., 1953; Atkinson, 1964) there exist as many motives as there are categories of expectations. The content category that might be called "need for achievement" is probably best defined as competition with a standard of excellence. The kind of activity involved may vary widely, as long as it is evaluated in the categories "better"-"worse."

This need for achievement seems to take two forms: hope for success and fear of failure (Atkinson, 1964). Atkinson defines these two tendencies as follows:

> It is assumed that the motive to achieve success, which the individual carries about with him from one situation to another, combines multiplicatively with the two specific situational influences, the . . . probability of success and incentive value of success . . ., to produce the tendency to approach success that is overtly expressed in the direction, magnitude, and persistence of achievement-oriented performance [1964, p. 242].

> It is assumed that in addition to a general disposition to seek success . . . there is also a general disposition to avoid failure . . . . Where the motive to achieve might be characterized as a capacity for reacting with pride in accomplishment, the motive to avoid failure can be conceived as a capacity for reacting with shame and embarrassment when the outcome of performance is failure. When this disposition is aroused within a person . . ., the result is anxiety and a tendency to withdraw from the situation [1964, p. 244].

As Atkinson and others have shown, the behavioral consequences of each tendency are quite different. For example, people motivated by hope for success prefer intermediate risk-levels in their actions, while those driven by the motive to avoid failure select either extremely high or extremely low risk levels (Atkinson, 1957).

### 4. Actual Achievement

By actual achievement we mean socially recognized, tangible results of individual effort. We decided that two indices were especially indicative of actual achievement among university professors, scholarly productivity, and rate of promotion. Both can be considered operationalizations of the concept of achievement but that is not to say that they measure exactly the same thing. Scholarly productivity is an aspect of achievement decidedly more under the control of the individual professor himself, while rate of promotion is the recognition of individual achievement by an institution, and thus one step more removed from motivational processes. Thus, we would expect stronger relationships between our variables and the man's productivity than between rate of promotion and variables like serum urate level or achievement motivation. Strictly speaking, of course, rate of productivity is also not completely under the man's control since he does not publish his books and papers himself. But we assume, probably justafiably so, that whether or not a piece of work will be published or not depends mostly on criteria germane to the work, while rate of promotion is comparatively more affected by criteria extrinsic to the man's work, and unrelated to its value (e.g., Caplow & McGee, 1958).

## Formulation of New Hypotheses

On the basis of his experimental validation studies, Heckhausen concludes: "In simple tasks, the speed or the amount of performance correlates with the total strength of the achievement motivation irrespective of the direction. In tasks that demand more of one's cognitive functioning it is not so much total motivation but the tendency toward success which correlates with the quality of the performance [1963, p. 241)." Since uric acid levels have been found to be related to achievement in demanding tasks (e.g., Brooks & Mueller, 1966), we predict a positive relationship between hope for success and a person's serum urate level. On the basis of the pilot results, discussed in Chapter I, we further predict a negative relationship between serum urate level and fear of failure.

Two correlates follow from these hypotheses: The relationship should become stronger when using the Heckhausen index "net hope for success," since it is computed by subtracting the fear of failure score from the hope for success score. Furthermore, there should be a reduced relationship between serum urate level and the index "total motivation" which Heckhausen computes by adding the hope for success and the fear of failure score. The relationship should be reduced to the degree to which a person's fear of failure score equals his hope for success score. Thus, to summarize, we want to test two major hypotheses and their correlates:

1. Under the conditions stated, there will be a positive correlation between serum uric acid level and hope for success.

2. Under the conditions stated, there will be a negative correlation between serum uric acid level and fear of failure.

Correlate a: The stated relationship between hope for success and serum urate level will be more strongly positive when the index "net hope for success" is used.

Correlate b: There will be a weaker bond between serum uric acid levels and the index of "total motivation" than between uric acid level and hope for success.

The predictions with respect to cholesterol are the exact opposite to those made for uric acid, in three of the four cases at least. Since in our conception striving out of a sense of hope for success is not seen as a psychological strain, and since cholesterol is seen as an indicator of such strain, we hypothesize a negative relationship between hope for success and serum cholesterol level. Analogously, serum cholesterol should be positively related to fear of failure, since we do conceive of fear of failure as psychological strain or at least the result of such strain. Similar in rationale to what was said earlier, there should be a weaker association between the index of total motivation and serum cholesterol than between either hope for success or fear of failure and serum cholesterol. However, the correlation should be even more strongly negative in the case of the relationship between "net hope" and serum cholesterol.

## Other Relationships

The above comprises the extent of our hypotheses, of those relationships about which we feel confident enough to state specific predictions. But in addition, many other relationships will be tested.

There is first the replication of the earlier study by Brooks and Mueller (1966). Here we expect to find a strong positive relationship between the index of achievement-oriented behavior and serum urate level, but since this is nothing new, we haven't included it in the section of new hypotheses.

Furthermore, we hope to find corollary evidence to our hypotheses by studying the same relationships with other indicators of motivation. We hope, for example, that there will be a positive relationship between uric acid and the McClelland/Atkinson score for need achievement, as well as a negative relationship of this score to cholesterol. We also take the number of hours worked per week as an indicator of motivation that should be related to our other test scores of motivation, and to the biochemical variable. But since the psychological meaning of working hard can be manifold, indicative of hope for success as well as fear of failure, we don't feel confident enough to state specific predictions.

And finally, we are most interested to see how all these indices relate to actual achievement, and to ask whether they relate to each other in similar fashion among all status levels. For example, it seems worthwhile to ask, whether the relationship between scholarly productivity and speed of promotion is the same at all levels of the academic hierarchy. The differences found in an earlier study (French et al., 1965) between full professors and academic administrators led us to expect possible differences.

# CHAPTER III

# METHODOLOGY

## Introduction

The design of this investigation is the cross-sectional, correlational study of a sample of university professors undergoing a periodic health examination. The purpose was to test prestated hypotheses about the relationship between uric acid and cholesterol, on the one hand, and motivation and achievement on the other hand. The operationalization of the hypotheses was to some degree left open. While not a follow-up, the study, in some parts, replicates an earlier investigation conducted six years ago.

For its own assurance and as a service to its staff The University of Michigan offers a multifaceted, intensive diagnostic health examination to all faculty members in five-year intervals. At the same time, the various medical units of The University use these medical examinations as research settings, for EKG studies, epidemiological investigations, and others. Being tuned in to research efforts has, for example, the effect, that records are kept in better shape than is often the case in hospitals, and that laboratory analyses are carried out with greater care. Finally, this awareness of the research obligation gives rise to a spirit of cooperation that is helpful indeed.

## The Sample

The sample of this study consisted of professors at The University of Michigan who entered the periodic faculty health examination between June 1, 1969 and November 15, 1969. It consisted only of males in the three academic ranks of assistant, associate, and full professor, and of academic administrators such as chairmen or deans who also hold professorial ranks. Table 2 compares the sample distribution by academic rank with the 1968-1969 distribution of ranks within The University. Since The University statistics do not list academic administrators separately, the sample is also divided only by academic rank. Table 3 compares the age distribution in the sample with the age distribution in The University faculty as a whole. The University statistics, however, are for the year 1961-1962. This is the most recent age breakdown of the faculty that is available.

## TABLE 2

## COMPARISON OF THE STATUS DISTRIBUTION OF THE ELIGIBLE SAMPLE WITH THE STATUS DISTRIBUTION OF THE UNIVERSITY AS A WHOLE

| | Assistant Professor | Associate Professor | Full Professor and Administrator |
|---|---|---|---|
| Distribution of the eligible sample | 27% | 26% | 47% |
| Distribution within The University | 23% | 24% | 53% |

## TABLE 3

## AGE DISTRIBUTION OF THE VARIOUS STATUS GROUPS IN THE ELIGIBLE SAMPLE, AND AGE DISTRIBUTION AT THE UNIVERSITY OF MICHIGAN IN 1961-1962*

| | Assistant Professor | Associate Professor | Full Professor and Administrator |
|---|---|---|---|
| Mean age distribution of the eligible sample | 37% | 43% | 52% |
| Mean age distribution within The University | 37% | 43% | 52% |

*1961-1962 is the most recent year for which an age distribution of all the faculty is available.

During the period of data collection, 131 men were eligible for our study. Those on academic leave were not included, neither were those professors included who had not at least a part-time affiliation with one of the departments. Of the 131 men eligible, 114 or 87% were willing to participate in our study. The response rate is in keeping with the general experience of the Institute for Social Research. Given the fact that data collection involved--aside from the physical examination--two interviews, and the completion of a curriculum vitae, the response rate seems quite respectable. Thus, the sample which is used for at least some sets of analysis consists of 114 professors and academic administrators. Table 4 compares the men in our sample with those refusing on those variables where comparable information was available. The only noticeable difference is with respect to length of service. Those who refuse have on the average been three years longer with The University than those who participate.

TABLE 4

COMPARISON OF THE REFUSALS WITH THOSE WILLING TO PARTICIPATE ON THOSE VARIABLES WHERE COMPARABLE INFORMATION WAS AVAILABLE

| Variable | Subjects who completed most of the questions | | | Those who refused and incompletes | | | Significance of Difference |
|---|---|---|---|---|---|---|---|
| | N | Mean | S.D. | N | Mean | S.D. | |
| Age | 99 | 46.34 | 9.15 | 32 | 48.13 | 8.44 | N.S. |
| Status | 99 | 2.46 | 1.04 | 32 | 2.44 | 0.79 | N.S. |
| Length of Service | 90 | 10.51 | 10.76 | 28 | 13.18 | 8.73 | $p < 0.05$ |
| SUA | 91 | 6.35 | 1.43 | 27 | 6.34 | 1.64 | N.S. |
| Cholesterol | 74 | 219.09 | 39.62 | 18 | 208.78 | 29.52 | N.S. |

## Source of the Data

In Table 5 below, we present an overview of the different ways in which the data for this study were collected. The information comes from semi-formal interviews, paper-and-pencil tests, a curriculum vitae, and the results of the physical examination.

TABLE 5

VARIOUS SOURCES OF THE DATA

| Part | Source and Content of the Data |
|---|---|
| 1 | (1) Short, structured interview dealing with the professor's state of health, some health habits, and position in the family of origin.<br>(2) A TAT-like measure of need achievement.<br>(3) Paper-and-pencil tests of need achievement, flexibility, social desirability, and extrinsic and intrinsic work motivation. |
| 2 | An open-ended interview dealing with the satisfactions and problems of the work situation. |

TABLE 5 (cont.)

| | |
|---|---|
| 3 | A curriculum vitae giving the professional history, honors, activities, and a list of publications. |
| 4 | A physical examination including laboratory tests and clinical appointments extending over a two-month period. |

Given such a set of diversified requests for information, it is not surprising that the return rates vary. Table 6 gives these rates for the various parts of the data collection process:

TABLE 6

RETURN RATE OF THE DATA

| | Completion Rate | |
|---|---|---|
| | N | % |
| Part 1 (1) | 114 | 86 |
| (2) | 110 | 83 |
| (3) | 114 | 86 |
| Part 2 | 112 | 84 |
| Part 3 | 107 | 81 |
| Part 4 | 92 | 69 |

Since some who answered all our questions did not get the full medical treatment, and others who failed to fill out a questionnaire underwent all examinations, the effective sample size sinks in some of the correlational analyses to as low as N = 72 or 56%. However, as we will try to show in the next chapter, we are unable to discover any systematic biases, but it should be kept in mind that the analysis of this study will have to operate with constantly varying numbers of subjects.

## The Data Gathering Procedure

The participation in the faculty health examination is voluntary, but between 75%-80% of all those invited participate, although not all of them complete all scheduled visits as Table 2 has shown. The professor is invited by a form letter sent out by the Periodic Appraisal Unit. After he had accepted this invitation he was contacted by a second letter sent to his home asking him to participate in an extension of the physical examination. We made no secrets about the fact that the additional participation would be lengthy, in fact, between two and three hours.

Within a week after the professor had received our letter, he was contacted by phone to hear whether he was willing to participate, and if so to ask for an appointment. It was at this point that our connection with the faculty health examination was probably most helpful. Frequently the professor acknowledged what he considered to be an obligation on his part to participate in return for having been given such a thorough examination. Aside from this, two reasons for participation stand out: An interest in the study, and, more important, a sense of duty to cooperate in a bona fide research effort, a sense of duty and obligation to the academic process.

If the professor chose to participate, a date and a place were set for the first interview, which was to last from 45 to 60 minutes. Whenever possible the meetings were conducted in the professor's office. If privacy could not be assured, the men were invited to the Institute for Social Research.

The first interview started with an explanation of the purposes of the study, without, however, revealing our hypothesis that uric acid is related to achievement. Care was taken to assure the professor of the confidentiality of the records. Then came questions as to the state of health and the health habits of the professor. Aside from our intrinsic interest in the answers to these questions, it was thought that rapport could be reached most easily via a series of such questions as how much do you weigh, and what kind of exercise do you do.

Next came the projective test trying to assess the person's hope for success and his fear of failure. In a later passage, we will talk in greater detail about this test. Here we want to point out that this was the least liked part of the data gathering process. The professors knew that they were projecting, didn't know exactly what about, and rather disliked this on the whole. Four who were fully cooperative in every other respect simply refused the test.

The first session ended with a set of questionnaire items, mainly of the true-false variety. Here the inevitable complaint, of course, was that the alternatives were too confining. At the end of the session, the professor was asked for a copy of his curriculum vitae. While only seven men failed to provide a vita, the quality of those received varied greatly. While many were clearly organized and up to date, others were narrative, and lacking in essential information to the extent that additional phone calls for clarification were needed.

The semi-structured interviews on work situation and work-related attitudes ranged in length from 45 minutes to two hours. From direct comments to the interviewer, from comments made to professors in the Institute, and from indirect comments via third persons we can rest assured that the professors found the interview thorough, comprehensive, and even therapeutic. From a direct question at the end of the interview, we learned that only four professors considered the interview superficial and beside the point. Nine others felt that additional areas, mainly the family life, should have been covered, but 88% expressed clear approval of scope and conduct. The interview asked identical questions of all professors. But within the interview the questions themselves varied in the degree to which they encouraged free and undirected responses in answering them. The introductory question was simply "How would you describe your job? What do you do?" On the other hand, the interview included such specific questions as "Could you estimate how many hours per week you spend on all your professional activities?"

At the end of the interview we thanked the man for his cooperation, collected the curriculum vitae, and assured him that upon completion of the study a resume of the findings would be sent to him. These summaries were sent out in December 1970.

## Problems and Shortcomings

About the greatest source of unknown error variance that was introduced into the study was the frequent delay in the medical examinations. More than was the case in the former study (French et al., 1965), professors seemed to delay their examinations, drop out, or skip certain tests. This led to the fact, difficult to interpret, that in some cases there was a three months lag between interview and the collection of blood specimen. And while it is generally true that serum urate levels are rather stable, significant variations over time have been found. (For a review of the evidence, see Mueller et al., 1970.)

It was assumed, to list another shortcoming of the study, that the professor would have a clear conception of what was meant by "curriculum vitae," that he would have such a resume readily available and up to date, and that these life descriptions would vary relatively little within The University. This, however, did not prove to be the case. The completeness of the information differed greatly, so did the recency of the sheets. On the other hand, attempts to get the professor to fill out a prepared, standardized form met with heavy resistance and had to be abandoned. Our answer to the problem was to weed out the most unreliable and sketchy resumes and to restrict our analysis to those that seemed relatively comparable. Of course, this reduced the number of cases available for analysis in a most unfortunate manner.

## The Variables and Their Measurement

### I. The Physiological Measurements

### A. Serum Uric Acid

Since this study is in many ways an extension, replication, and an outgrowth of our earlier study of professors, we will in many cases direct the reader to this earlier report in order to avoid unnecessary duplication.

The concentration of uric acid in the serum was measured by the auto-analyzer method. This is a colorimetric method which, however, avoids most of the difficulties associated with the nonautomated colorimetric methods used in the past (Mueller et al., 1970). The determinations were performed by the laboratory technicians of The University of Michigan Hospital. Table 7 presents the values in the various status groups comparing them to the values found in the earlier study.

TABLE 7

MEAN URIC ACID LEVEL DISTRIBUTED BY STATUS LEVEL IN 1969 AND IN 1963

| Status | 1969 | | | 1963 | | |
|---|---|---|---|---|---|---|
| | Mean Value of SUA | | | Mean Value of SUA | | |
| | N | Mean | S.D. | N | Mean | S.D. |
| Total sample | 118 | 6.35 | 1.47 | 113 | 5.66 | 1.17 |
| Assistant professor (a) | 26 | 6.46 | 1.66 | 48 | 5.50 | 1.07 |
| Associate professor (b) | 28 | 6.10 | 1.58 | 23 | 5.50 | 1.13 |
| Full professor (c) | 46 | 6.35 | 1.25 | 29 | 5.95 | 1.20 |
| Academic administrator (d) | 18 | 6.56 | 1.63 | 13 | 5.92 | 1.45 |
| Significance of the difference among groups (a)-(d) | $F = 0.43$, $p > 0.05$ | | | $F = 1.29$, $p > 0.05$ | | |

It is interesting to note that this represents an increase in mean level for the total sample 0.79 mg/100 ml ($p < 0.01$) between 1963 and 1969. While it is true that methods changed between 1963 (uricase method) and 1969 (auto-analyzer method) it is unlikely that a difference of this magnitude can be seen as an artifact of the method (Mueller et al., 1970). This secular trend has now repeatedly been suggested, and since the auto-analyzer method has by now become nearly standard, it is only a matter of time until a study will be able to document this trend in a methodologically unassailable fashion.

Taking the sample as a whole, uric acid is not related in any significant way to age ($r = -.05$), weight ($r = 0.16$), systolic blood pressure ($r = .13$), diastolic blood pressure ($r = .07$), or cholesterol ($r = -.07$). It is, however, negatively and significantly related to a person's fasting blood sugar level ($r = -.23$).

## B. Serum Cholesterol

Determinations of cholesterol levels are done as a matter of course during the periodic health examinations of the faculty. However, since it requires a separate visit rather a large number of professors simply skipped this examination, resulting in a relatively low N for all analyses involving cholesterol. The collection is under the supervision of a research cardiologist. The method used is that by Mann (1961). It is basically an extension of the method developed by Abell et al. (1952). It is a photometric method using a solution of iron and sulfuric and acetic acid as a reagent, and measures the changes in optical density. The relation of optical density and cholesterol concentration is linear. The technical error of this method by Mann is 11.0 mg/100 ml. Table 8 shows the distribution of serum cholesterol values in the various status groups.

TABLE 8

MEAN SERUM CHOLESTEROL LEVEL DISTRIBUTED BY STATUS GROUP
(expressed in mg/%)

| Status | Mean Value of Serum Cholesterol | | |
|---|---|---|---|
| | N | Mean | S.D. |
| Total sample | 92 | 217.08 | 37.93 |
| Assistant professor (a) | 23 | 228.91 | 47.29 |
| Associate professor (b) | 25 | 214.64 | 36.76 |
| Full professor (c) | 32 | 207.50 | 32.38 |
| Academic administrator (d) | 12 | 225.00 | 29.79 |
| Significance of the differences among groups (a) - (d) | $F = 1.67$, $p > 0.05$ | | |
| Significance of the differences among groups (a) - (c) | $F = 2.12$, $p > 0.05$ | | |

The relationship between status and cholesterol, while not significant, is nevertheless noteworthy in its negative trend, the higher the status the lower the cholesterol level. This is the more noteworthy because it counteracts the well-established relationships between age and status and between age and cholesterol. For this reason we put the three variables cholesterol, age, and status into a correlogram and controlled by partial correlation (Guilford, 1956) for the influence of the variables on each other. Figure 2 presents the data.

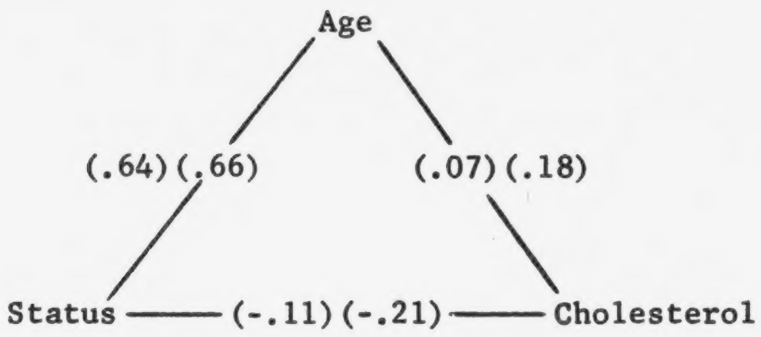

Figure 2. Correlogram illustrating the relationships between the variables cholesterol, age, and status. In each pair the first figure is the raw correlation while the second figure is the correlation partialling out the third variable.

First, partialling out the effect of status on the relationship between age and cholesterol raises the correlation coefficient to $r = 0.18$. While this too is not significant, it is more in line with previous findings in the literature. On the other hand, controlling the negative relationship between status and cholesterol for the counteracting influence of age raises the coefficient to $r = -.21$ ($p < .05$). If one accepts as well documented the notion that cholesterol levels can be indicators of psychosocial stress, then this finding leads one to suggest that job pressure decreases as one goes up the status ladder until one is burdened with the chores of academic administration.

Cholesterol is not related to any of the other medical variables, neither blood pressure (systolic: $r = -.12$; diastolic: $r = .00$), fasting blood sugar level ($r = .18$), nor even weight ($r = .11$).

## II. The Measures of Motivation and Behavior

### A. The Measures of Motivation

1. The Heckhausen test for achievement motivation. The recognition of the conceptual difference between the two motivational tendencies led to attempts to measure them separately, either by using differing scoring keys for the same test (Moulton, 1958), or by assessing each tendency by a different method, hope for success by content analysis of TAT-stories and the tendency to avoid failure by questionnaire methods (e.g., Feather, 1961, 1962). Moulton's exploratory attempt was not followed up in the United States, and the anxiety questionnaires used for the assessment of the tendency to avoid failure are either too specifically related to test anxiety (Mandler & Sarason, 1952) or too general (Taylor, 1953) to be wholly acceptable. Thus, the effort by Heckhausen and his co-workers in Germany who took up Moulton's approach to the problem seemed to represent a clear step forward.

Heckhausen's TAT-like test consists of six pictures, three taken from the McClelland-Atkinson need achievement TAT designed to stimulate the tendency hope for success, and three newly developed pictures intended to arouse fear of failure. Herein lies one of the differences from Moulton who did not try to develop specific fear of failure pictures.

The test was taken individually. With respect to each picture the subject was asked four questions: (1) What is going on--who are the people? (2) What has happened before? (3) What do the people think and intend to do? (4) How is the situation going to end? The subject answers these questions in writing on a prepared sheet. Each story was coded for hope for success and fear of failure according to certain analytical, culture-free categories such as positive and negative expectations, affective state, dominant theme and others. The summation of the two scores yielded an index of total motivation. Subtracting the fear of failure score from the hope for success score gave an index of net hope for success. Heckhausen (1963) provides a scoring manual, and a training course. Two coders trained themselves to reach a reliability of above .85 for scoring hope for success and fear of failure in the training stories provided by Heckhausen. This, by the way, took several weeks.

After this, one scorer scored all the protocols, then both scorers worked independently on 24 randomly selected cases. The relevant reliability data are given in Table 9 and Table 10.

TABLE 9

DATA ON THE RELIABILITY SCORING FOR HOPE FOR SUCCESS BY TWO SCORERS

| Hope for Success | Rater M | Rater B | Significance of Difference |
|---|---|---|---|
| Mean | 6.75 | 6.88 | N.S. |
| Standard deviation | 2.22 | 2.35 | N.S. |
| Correlation between Rater M and Rater B | r = .65, N = 24 (estimated reliability = 0.79) | | |

## TABLE 10

## DATA ON THE RELIABILITY SCORING BY TWO SCORERS OF FEAR OF FAILURE

| Fear of Failure | Rater M | Rater B | Significance of Difference |
|---|---|---|---|
| Mean | 3.63 | 4.17 | N.S. |
| Standard deviation | 2.61 | 2.56 | N.S. |
| Correlation between Rater M and Rater B | r = .82, N = 24 (estimated reliability = 0.90) | | |

In a series of studies reported by Heckhausen (1963), the test yielded many theoretically meaningful relationships pointing to a satisfactory construct validity. So, for example, it was possible to replicate the Atkinson findings on levels of risk taking (1957) using the new scoring techniques. In another study, it was found that those with high hopes for success experience time as fast moving and directed toward a goal, while those motivated by the tendency to avoid failure see time as flowing without beginning and end, undirected, and goalless. In summary, it seemed that while the test was by no means suited for the clinical diagnosis of individuals, as a research tool it represented an improvement over earlier methods.

Since there was a significant correlation between number of words in the protocol and the motivation scores, we corrected the motivation scores for length of protocol according to the method described by Veroff et al. (1960). The correction factor was obtained from the regression line based on the average correlation of hope for success, fear of failure, total motivation, and net hope and length of protocol. The correction factor equals the mean motivation score for the whole sample minus the mean "expected" motivation score for protocols of particular length. Table 11 gives the correlations between motivation score and length of protocol before and after correction.

## TABLE 11

## CORRELATION BETWEEN MOTIVATION SCORES AND LENGTH OF PROTOCOL BEFORE AND AFTER CORRECTION FOR LENGTH OF PROTOCOL

| Motivation Score | Correlation with Length of Protocol | |
|---|---|---|
| | Before Correction | After Correction |
| Hope for success | 0.38, $p < .01$ | 0.12, N.S. |
| Fear of failure | 0.16, N.S. | -0.11, N.S. |
| Total motivation | 0.39, $p < .01$ | 0.12, N.S. |
| Net hope | 0.19, $p < .05$ | -0.16, N.S. |

The analyses were run both ways, using the uncorrected, and the corrected measures. The average correlation between the corrected and the uncorrected measures is $r = 0.93$. The differences in the results appear to be random. Table 12 to Table 15 give the distribution of the motivation scores corrected for length of protocol in the various status groups.

The following tables give the mean and the variance of the various motivation scores for the different status groups. It should be noticed that "1o" was added to the net hope scores to get rid of negative values.

## TABLE 12

## DISTRIBUTION OF TOTAL MOTIVATION SCORES AMONG THE DIFFERENT STATUS GROUPS (corrected for length of protocol)

| Status | Mean Value of Total Motivation | | |
|---|---|---|---|
| | N | Mean | S.D. |
| Total sample | 110 | 12.18 | 4.06 |
| Assistant professors (a) | 25 | 11.35 | 4.06 |
| Associate professors (b) | 25 | 12.68 | 4.14 |
| Full professors (c) | 43 | 12.17 | 4.28 |
| Academic administrators (d) | 17 | 12.66 | 3.47 |
| Significance of differences among groups (a) - (d) | $F = 0.55$, $p > 0.05$ | | |

## TABLE 13

## DISTRIBUTION OF NET HOPE SCORES (corrected for length of protocol) AMONG DIFFERENT STATUS GROUPS

| Status | Mean Value of Net Hope Scores | | |
|---|---|---|---|
| | N | Mean | S.D. |
| Total sample | 110 | 13.12 | 4.12 |
| Assistant professors (a) | 25 | 13.35 | 4.72 |
| Associate professors (b) | 25 | 13.32 | 4.25 |
| Full professors (c) | 43 | 13.19 | 3.66 |
| Academic administrators (d) | 17 | 12.30 | 4.38 |
| Significance of differences among groups (a) - (d) | $F = 0.27, p > 0.05$ | | |

## TABLE 14

## DISTRIBUTION OF HOPE FOR SUCCESS SCORES (corrected for length of protocol) AMONG DIFFERENT STATUS GROUPS

| Status | Mean Value of Hope for Success Scores | | |
|---|---|---|---|
| | N | Mean | S.D. |
| Total sample | 110 | 7.67 | 2.92 |
| Assistant professors (a) | 25 | 7.36 | 3.14 |
| Associate professors (b) | 25 | 8.24 | 3.17 |
| Full professors (c) | 43 | 7.61 | 2.90 |
| Academic administrators (d) | 17 | 7.48 | 2.35 |
| Significance of differences among groups (a) - (d) | $F = 0.44, p > 0.05$ | | |

TABLE 15

DISTRIBUTION OF FEAR OF FAILURE SCORES (corrected for length of protocol) AMONG DIFFERENT STATUS GROUPS

| Status | Mean Value of Fear of Failure Scores | | |
|---|---|---|---|
| | N | Mean | S.D. |
| Total sample | 110 | 4.50 | 2.90 |
| Assistant professors (a) | 25 | 3.99 | 3.00 |
| Associate professors (b) | 25 | 4.26 | 2.80 |
| Full professors (c) | 43 | 4.67 | 2.72 |
| Academic administrators (d) | 17 | 5.18 | 3.37 |
| Significance of differences among groups (a) - (d) | $F = 0.67$, $p > 0.05$ | | |

2. The McClelland/Atkinson measure of need achievement (n. ach.). Heckhausen's system of motive scoring was developed following the directions given in the work of McClelland, Atkinson and others (McClelland et al., 1953; Atkinson, 1958). For this reason we also had the stories of the professors scored according to this system of motive scoring. A senior undergraduate student was trained under expert guidance mainly by completing the scoring course detailed in Atkinson's book *Motives in Fantasy, Action, and Society*. When he was judged competent he scored all stories of the 110 subjects who had completed the Heckhausen pictures. After an interim of eight weeks he rescored the stories of every seventh subject. The rater-self reliability was 0.92. These scores too were corrected for length of protocol according to the procedure outlined by Veroff et al. (1960), since the correlation between motive score and length of protocol was $r = 0.35$ ($p < 0.01$). Table 16 gives the distribution of the data in the various status groups.

TABLE 16

DISTRIBUTION OF THE N. ACH. SCORES AMONG THE DIFFERENT STATUS GROUPS CORRECTED FOR LENGTH OF PROTOCOL

| Status | Mean Values of n. ach. Scores | | |
|---|---|---|---|
| | N | Mean | S.D. |
| Total sample | 109 | 15.82 | 6.06 |
| Assistant professors (a) | 25 | 16.42 | 6.85 |
| Associate professors (b) | 24 | 14.25 | 6.03 |
| Full professors (c) | 43 | 16.14 | 6.21 |
| Academic administrators (d) | 17 | 16.36 | 4.40 |
| Significance of differences among groups (a) - (d) | $F = 0.70,\ p > 0.05$ | | |

## B. Measures of Achievement Oriented Behavior

The measure used was developed six years ago in an earlier study (French et al., 1965), and is described in great detail there. The measure consists of ratings of interviews along seven dimensions. These seven dimensions are described extensively in French et al. (1965). Here, we will give a more general description which, we hope, will be sufficient for an understanding of the measure.

Achievement and self-confidence: Here the professor's occupational self-esteem is assessed as it expresses itself in the interview by the reporting of achievements--papers, books, honors, etc.--and by an assessment of the degree of pride with which he reports these achievements.

Drive: Here we rated a life style. We tried to assess the individual's output of energy, and the intensity of living and working.

Leadership: This variable is a measure of the tendency to lead others by persuasion. It involves strong interest in the smooth functioning of interpersonal relations. It is closely related to what Mann (1965) calls "human relations skills" and involves leading others in goal achievement.

Range of activities: The use of professional skills in off-campus activities at the national, state, and community level was rated. Any indication that a man engages in a wide variety of activities will raise his score on this dimension. The use of this dimension was suggested by the work of Dunn et al. (1963) who found a significant association between the number of activities high school students engaged in and their serum uric acid levels.

Pushing of self: Along this dimension the persistence and tenacity in the pursuit of professional goals was rated. In order to assess this dimension, all indications were coded that the professor was pressing himself to the limits of his capacity. We found this expressed in the number of hours, for example, he reportedly works in an average week. The correlation is $r = .32$ ($p < .01$).

Emphasis on research: Here we rated the relative importance of, and preference for research as compared with teaching. We took this rating as an operationalization of status striving in the current academic environment. We find justification for this operationalization in the work of Caplow and McGee who conclude that when professors "are evaluated . . ., either as candidates for a vacant position, or as candidates for promotion, the evaluation is made principally in terms of their research and contributions [1958, p. 82]." Any measure of achievement oriented behavior should include an assessment of status striving, but the particular operationalization may have to vary from group to group. If we had to develop the measure anew, we would already probably be looking for other behavioral indications of status striving. But, of course, it was essential for reasons of comparability to use the same standards that were used in our previous study.

Attitude toward pressure: The people who scored highest on this question seemed to thrive on pressure and challenge. We tried to rate to what extent the professor suffered under pressure, and to what extent he was able to bear it lightly without too much concern.

The data used in assessing these dimensions came from the 60-90 minute interview with the professor. The questions were the same ones that were asked in the previous study, and the same coding instructions applied. Also the procedure was similar. The interviews were rated blindly, i.e., without any knowledge of the professor's uric acid level. However, this time two raters were not available. Therefore, no interrater reliability could be established. However, the repeat rating reliability after six weeks is $r = 0.81$ which seems highly acceptable. This is the repeat reliability of the total AOB score (Achievement Oriented Behavior score). A further difference from the procedure six years ago is the computation of the scores. Then, the individual scores of the two raters were summed to form a combined score ranging from two to six for each of the seven dimensions, and from fourteen to forty-two for the total AOB score. This time, since a second rater was not available, the scores consist of the rating values of one person, i.e., ranging from one to three for the individual dimensions, and from seven to twenty-one for the total index. Broken down by status groups the mean values of the achievement orientation index are shown in Table 17.

There are no significant status differences, although it should be pointed out the F-value approaches significance, thus at least in part confirming earlier findings (French et al., 1965) that showed associate professors rated lowest in achievement oriented behavior. For a further discussion of the measure and additional information, the reader is directed to the earlier report.

TABLE 17

MEAN VALUES OF ACHIEVEMENT ORIENTATION SCORES
DISTRIBUTED BY STATUS LEVEL

| Status | Mean Value of Achievement Orientation Scores | | |
|---|---|---|---|
| | N | Mean | S.D. |
| Total sample | 102 | 14.75 | 2.45 |
| Assistant professors (a) | 23 | 14.48 | 1.95 |
| Associate professors (b) | 21 | 13.62 | 2.48 |
| Full professors (c) | 41 | 15.20 | 2.35 |
| Academic administrators (d) | 17 | 15.41 | 2.90 |
| Significance of differences among groups (a) - (d) | F = 2.56, N.S. | | |

C. Measure of Work Effort

During the interview we asked the professor to tell us how many hours he works during the average week. We used this measure in two ways: (a) as an indirect assessment of work motivation, and (b) as the best approximation to his habitual, not only present, work output. From our previous study in which statements of the man were checked against the answers his wife gave to a similar question, we know that these statements as to the amount of work hours are fairly trustworthy. Table 18 presents the relevant data for the various status groups.

TABLE 18

MEANS AND STANDARD DEVIATIONS FOR THE NUMBER OF HOURS WORKED
IN AN AVERAGE WEEK IN THE VARIOUS STATUS GROUPS

| Status | Mean Number of Hours Worked per Average Week | | |
|---|---|---|---|
| | N | Mean | S.D. |
| Total sample | 112 | 57.80 | 11.00 |
| Assistant professors (a) | 25 | 55.68 | 8.68 |
| Associate professors (b) | 25 | 55.52 | 6.80 |
| Full professors (c) | 45 | 59.78 | 13.03 |
| Academic administrators (d) | 17 | 59.00 | 12.76 |
| Significance of differences among groups (a) - (d) | F = 1.73, p > 0.05 | | |

These findings are virtually the same that were obtained in our earlier study. They show that while full professors and administrators tend to show a greater number of work hours, the differences are far from significant, so that it is fair to conclude that there are no status differences with respect to the effort a man puts into his work.

## III. The Achievement Measures

### A. Rate of Progression

It seemed reasonable to assume that the speed with which a man advances in his profession could be taken as an index of achievement. We conceived of "rate of advancement" as the number of years between receiving the bachelor degree and appointment to the highest position plus years in the highest position for assistant and associate professors. This number of years was divided by the number of steps the man had advanced. Appointment to administrative offices was not considered a further advancement.

As with all measures in this area this one too is burdened with certain shortcomings: (1) In the ranks of assistant and associate professors, it is a relatively unstable measure depending on one or two promotions. (2) It penalizes those that at any time in their career have taken detours like government appointments, post-doctoral fellowships, etc. It also discriminates against foreigners, or those for whom university life is a second career.

On the other hand, it does say something about the nature of a man's attitude toward his career to know that, shunning all detours, he has single-mindedly pursued his course. We are not sure whether it is such a narrow career-striving that will be related to uric acid, but the conception is fairly clear.

We computed this measure in several different forms: (1) as described above; (2) considering strictly the age of appointment to highest status, without counting the years in the highest status category. (3) Each of the above mentioned two forms were computed as deviation (z-score) from the average rate of progression in one's status groups. This was done to see whether there are any cohort effects. (4) Each of the indices described under (1) and (2) was computed as deviation from the average age of appointment in one's general discipline, social work, engineering, etc. This was supposed to show whether there are any pronounced within-university differences in rate of advancement. The correlation between all these measures is given in Table 19.

## TABLE 19

## INTERCORRELATIONS AMONG VARIOUS WAYS OF COMPUTING A RATE OF PROGRESSION INDEX FOR UNIVERSITY PROFESSORS

| Variable | 1 | 2 | 3a | 3b | 4a |
|---|---|---|---|---|---|
| Rate of progression (1)* | | | | | |
| Rate of progression (2) | .85 | | | | |
| Rate of progression (3a) | .80 | .70 | | | |
| Rate of progression (3b) | .69 | .82 | .88 | | |
| Rate of progression (4a) | .87 | .79 | .70 | .65 | |
| Rate of progression (4b) | .80 | .89 | .68 | .78 | .89 |

*The numbers refer to the different forms of the indices described in the text.

Because index (1) tended to give the most consistent answers when compared to the others, we decided to use the number of years between BA degree and appointment to highest status plus the number of years in the highest position (for assistant and associate professors) divided by the number of status steps as index for further analysis. The distribution of advancement scores in the various status groups is given in Table 20.

## TABLE 20

## MEANS AND STANDARD DEVIATIONS OF THE SCORES FOR RATE OF ADVANCEMENT IN THE VARIOUS STATUS GROUPS

| Status | Mean Value of Rate of Advancement | | |
|---|---|---|---|
| | N | Mean | S.D. |
| Total sample | 107 | 8.81 | 3.71 |
| Assistant professors (a) | 24 | 12.23 | 4.33 |
| Associate professors (b) | 23 | 9.17 | 3.48 |
| Full professors (c) | 43 | 7.15 | 1.87 |
| Academic administrators (d) | 17 | 7.48 | 3.46 |
| Significance of differences among groups (a) - (d) | Analysis of Variance not possible because of inhomogeneity of variance | | |

Even without the computation of an analysis of variance the decrease in the number of years spent at a given status step is very noticeable. The correlation between status and advancement is $r = 0.49$ ($p < 0.01$). The interpretation is complicated by the fact that we can't be sure that the measure means the same on all status levels. While it may represent a valid assessment of rate of advancement for a full professor, for an assistant professor it may only reflect factors over which the man has no full control such as length of dissertation, or it may reflect his willingness to undertake detours before settling on a career line.

The decreasing magnitude of the variance, however, also suggests another interpretation, namely that assistant professors are the least selected groups including not only future full professors at The University of Michigan, but also those that leave for smaller institutions, while those that are full professors at this University represent a select group whose qualifications should indeed show, among other things, in their rate of advancement.

## B. Scholarly Productivity

The second variable indicating achievement used in this study is an index of yearly scholarly productivity. From the professor's curriculum vitae the number and type of publications were obtained. Following Cartter (1966) all publications were expressed in article equivalents, counting an original book or lengthy monograph as six articles, editions, or textbooks as three, and technical reports as equivalent to 1/2 an article. The number so obtained was divided by the number of years passed since first publication. Year of first publication was chosen rather than year of highest degree so as not to punish unduly those who started publishing later in their careers mainly because they came to The University only later in life.

As with the measure of advancement, this too was computed in various forms: (1) As described above, add up the number of article equivalents and divide by number of years passed since date of first publication. (2) Since the distribution of scores computed in the way described above is not normal but rather approaches the J-curve, the logarithmic transformation suggested by Pelz and Andrews (1966) was performed normalizing the distribution. (3a, 3b) Indices (1) and (2) were computed as deviation (z-score) scores, expressing the man's productivity relative to his status group. (4a, 4b) Indices (1) and (2) were computed as deviation (z-scores) scores, expressing the man's productivity relative to his discipline. The sample for this analysis is reduced since we did not feel competent to evaluate the "scholarship," or the scholarship-equivalent for men in the performing disciplines such as music and art. The intercorrelation of the various computational forms of the productivity index is given in Table 21.

TABLE 21

INTERCORRELATION AMONG VARIOUS WAYS OF COMPUTING AN INDEX OF PRODUCTIVITY FOR UNIVERSITY PROFESSORS

| Variable | 1 | 2 | 3a | 3b | 4a |
|---|---|---|---|---|---|
| Productivity (1)* | | | | | |
| Productivity (2) | .93 | | | | |
| Productivity (3a) | .94 | .92 | | | |
| Productivity (3b) | .89 | .96 | .96 | | |
| Productivity (4a) | .94 | .92 | .90 | .88 | |
| Productivity (4b) | .90 | .96 | .88 | .92 | .96 |

*The number refers to the description of the indices in the text.

Because of the extremely high correlation between Index 1 and the other ways of computing a productivity measure, we choose to use this index for further analysis. It is the measure most easily interpretable without any obscuring of the meaning due to statistical transformations. Because of the close correspondence between the simple and the logarithmically transformed measures we will take the liberty and use this measure in analyses normally requiring normal distribution of the variable. The distribution of the productivity scores for the various status groups is given in Table 22. Again, we have to point out that by necessity the measure is of greater stability for the higher ranks.

TABLE 22

MEANS AND STANDARD DEVIATIONS OF THE PRODUCTIVITY SCORES FOR THE VARIOUS STATUS GROUPS

| Status | Mean Value of Productivity Score | | |
|---|---|---|---|
| | N | Mean | S.D. |
| Total sample | 97 | 1.86 | 1.46 |
| Assistant professors (a) | 23 | 1.42 | 1.22 |
| Associate professors (b) | 22 | 1.60 | 0.85 |
| Full professors (c) | 38 | 2.21 | 1.54 |
| Academic administrators | 14 | 2.06 | 2.09 |
| Significance of differences among groups (a) - (d) | Analysis of Variance not possible because of inhomogeneity of variances | | |

Even though analysis of variance is not advisable in this case, the correlation between status and productivity supports the general impression. The correlation is $r = .21$ ($p < 0.05$). Again, this finding is very difficult to interpret but taking into account that productivity tends to decrease with age, somewhat offsetting the disadvantage of the young man just entering the field, one is again confronted with the interpretation that the higher productivity of full professors and the academic administrators is evidence of their general level of achievement.

## Relationship between the Motivational Indices and the Measures of Achievement

To understand better the somewhat puzzling findings to be presented later on, it may help to compare the motivational measures with each other and with the indices of actual achievement.

If there is any justification to applying the label achievement motivation to the interpretation of TAT-stories used in this study, then the test should correlate with actual indices of achievement. However, we do not know enough about the relationship between motivation and something as complex as occupational achievement to predict whether approach or avoidance motivation should result in higher productivity or faster promotion. Table 23 and Table 24 present the relevant data for the various status groups.

TABLE 23

CORRELATION BETWEEN THE VARIOUS TENDENCIES OF ACHIEVEMENT MOTIVATION AND RATE OF OCCUPATIONAL PROGRESS IN THE VARIOUS STATUS GROUPS AND THE TOTAL SAMPLE OF PROFESSORS

| Motivational Tendency | Total N = 102 | Assist. N = 24 | Assoc. N = 22 | Full N = 39 | Adminstr. N = 17 |
|---|---|---|---|---|---|
| Total motivation | -0.08 | -0.09 | -0.32 | -0.08 | -0.11 |
| Net hope | -0.16 | -0.21 | -0.04 | -0.07 | -0.23 |
| Hope for success | -0.22* | -0.25 | -0.40 | -0.10 | -0.37 |
| Fear of failure | 0.16 | 0.18 | 0.04 | -0.02 | 0.23 |
| n. ach. | -0.26 | -0.54 | -0.22 | -0.09 | -0.30 |
| Number of work hours | 0.06 | -0.30 | 0.09 | 0.34 | -0.22 |
| Achievement oriented behavior | -0.24 | 0.09 | 0.36 | 0.26 | 0.08 |

*The underlined coefficients are significant at better than the 0.05 level. The signs of the coefficients have been reversed to permit easier reading of the table. The meaning is that men who have progressed fast, in few years, will have high motivation scores.

## TABLE 24

### CORRELATIONS BETWEEN THE VARIOUS TENDENCIES OF ACHIEVEMENT MOTIVATION AND THE AMOUNT OF SCHOLARLY PRODUCTIVITY IN THE VARIOUS STATUS GROUPS AND THE TOTAL SAMPLE

| Motivational Tendency | Total N = 93 | Assist. N = 23 | Assoc. N = 21 | Full N = 35 | Adminstr. N = 14 |
|---|---|---|---|---|---|
| Total motivation | -0.21* | -0.23 | -0.11 | -0.39 | 0.06 |
| Net hope | -0.12 | -0.08 | -0.07 | -0.21 | -0.04 |
| Hope for success | -0.25 | -0.18 | -0.22 | -0.43 | -0.03 |
| Fear of failure | -0.02 | -0.16 | 0.14 | -0.14 | 0.12 |
| n. ach. | -0.07 | -0.19 | 0.11 | -0.23 | 0.35 |
| Number of work hours | 0.25 | -0.11 | 0.43 | 0.19 | 0.41 |
| Achievement oriented behavior | 0.29 | 0.73 | 0.28 | 0.22 | 0.03 |

*Underlined coefficients are significant at better than the 0.05 level.

Before trying to interpret these relationships it might be helpful to present two other sets of findings: (a) the correlation matrix of the variables under consideration, and (b) some consideration of the possible curvilinearity of the relationships. This is done in Tables 25 and 26.

## TABLE 25

### INTERCORRELATION OF THE INDICATORS OF MOTIVATION AND THE INDICES OF ACTUAL ACHIEVEMENT

| Variable | | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Hope success | (1) | -0.03 | 0.70 | 0.65 | -0.22 | -0.25 | -0.16 | 0.50 | -0.12 |
| Fear of failure | (2) | ..... | 0.68 | -0.67 | 0.16 | -0.02 | -0.06 | 0.04 | -0.11 |
| Total motivation | (3) | | | -0.04 | -0.08 | -0.21 | -0.16 | 0.39 | -0.18 |
| Net hope | (4) | | | | -0.16 | -0.12 | -0.06 | 0.27 | 0.00 |
| Rate of progress | (5) | | | | | 0.27 | 0.06 | -0.26 | 0.24 |
| Productivity | (6) | | | | | | 0.25 | -0.07 | 0.29 |
| Work hours | (7) | | | | | | | 0.16 | 0.17 |
| n. ach. | (8) | | | | | | | | 0.10 |
| Achievement oriented behavior | (9) | | | | | | | | |

NOTE: The signs of coefficients involving progression have been changed to permit easier reading of the matrix. The meaning is that men progressing fast have high values on the related variable.

To check the shape of the distributions we divided the sample into approximate quartiles and quintiles on the motivational tendencies, and computed the means of these subgroups for rate of progression, productivity, and number of work hours. The results are presented in Table 26.

TABLE 26

MEANS ON RATE OF PROGRESSION, PRODUCTIVITY, AND NUMBER OF WORK HOURS FOR SUBGROUPS HIGH AND LOW ON THE MOTIVATIONAL TENDENCIES

| Variable | | Hope for Success | | Fear of Failure | | Net Hope | | Total Motivation | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | Mean | N | Mean | N | Mean | N | Mean |
| Low | 1 | 24 | 7.9 | 25 | 9.5 | 14 | 7.5 | 21 | 8.1 |
| RATE OF | 2 | 25 | 8.1 | 29 | 8.3 | 22 | 9.0 | 17 | 9.2 |
| PROGRESSION | 3 | 25 | 9.7 | 23 | 9.4 | 23 | 8.1 | 23 | 9.0 |
| | 4 | 24 | 9.9 | 21 | 8.3 | 18 | 9.4 | 20 | 8.4 |
| High | 5 | | | | | 21 | 10.1 | 17 | 10.1 |
| Low | 1 | 22 | 2.21 | 24 | 1.68 | 12 | 1.52 | 19 | 2.37 |
| | 2 | 22 | 2.00 | 26 | 2.44 | 19 | 2.23 | 16 | 1.95 |
| PRODUCTIVITY | 3 | 24 | 1.82 | 22 | 1.41 | 23 | 1.99 | 22 | 1.88 |
| | 4 | 23 | 1.34 | 19 | 1.70 | 18 | 1.99 | 17 | 1.27 |
| High | 5 | | | | | 19 | 1.31 | 17 | 1.65 |
| Low | 1 | 26 | 61 | 29 | 57 | 17 | 58 | 23 | 60 |
| NUMBER OF | 2 | 30 | 57 | 30 | 61 | 24 | 59 | 19 | 59 |
| WORK HOURS | 3 | 26 | 58 | 25 | 56 | 24 | 60 | 27 | 58 |
| | 4 | 26 | 56 | 24 | 58 | 20 | 55 | 21 | 56 |
| High | 5 | | | | | 23 | 56 | 18 | 56 |

It can be seen from the above table what the correlations have already shown: that there exists an inverse linear relationship between hope for success and the three variables considered. Compared with this, fear of failure shows a tendency toward curvilinearity which, although not significant, is noticeable with respect to all three variables, going in the direction of a moderate amount of fear of failure as most effective in motivating toward fast progression, high productivity, and long work weeks.

The lack of any clear relationship of net hope and total motivation to the variables "rate of progression," "productivity," and "number of work hours" seems to be the natural consequence of combining or subtracting these two differing distributions.

The essential aspect of the preceding analyses is the consistent inverse relationship between hope for success and the indicators of actual achievement. It is hard to imagine a theoretical position that would expect a linearly distributed measure of the motivation to achieve success to be negatively related to indicators of achievement. We interpret this very consistent finding by hypothesizing that the stories told to these TAT-like pictures do not express the motivation to seek success; but that they rather express the degree of deprivation of this motive to have success, that they express concern over achievement rather than motivation to achieve. It might bolster this interpretation to point out that the telling of success-oriented stories is not seen by our subjects as the socially desirable thing to do. The correlation between hope for success and social desirability as measured by the Marlowe-Crowne scale is $r = -0.19$ ($p < 0.05$) which indicates that the relationship tends to go into the opposite direction, that those who are concerned about social desirability of their actions tend to tell stories referring little to hope for success.

That this interpretation deserves serious consideration is indicated by the fact that scoring these stories according to a different system of need achievement scoring, namely the one developed by McClelland, Atkinson and others, yields substantially the same inverse relationship between the measure of need for achievement and the indicators of actual achievement.

Finally, it is worthwhile to note the large discrepancies in some of the relationships on the different status levels. For example, the length of the present work week is negatively related to occupational progress in the group of assistant professors, but positively related among the full professors. While neither coefficient is significant in its own right, it is improbable that the two relationships could be found in the same population ($z = 2.43$, $p < 0.01$). In other words, whatever the relationship between hard work and rate of promotion may be, it is different in assistant professors and full professors, and, for that matter, in academic administrators. We will return to an interpretation of such differences in a later section.

## Restatement of the Hypotheses

On the basis of what we have found about the relationship of the Heckhausen test to the indicators of achievement, it now seems advisable to restate the hypotheses. Considering the hope for success score an indicator for concern over lack of success, and assuming uric acid being related to positive striving for success, we would now hypothesize a negative correlation between the Heckhausen hope for success score and a person's serum urate level.

Since cholesterol is seen as an indicator of stress and strain, and since concern over lack of success is assumed to be a psychological strain, we hypothesize a positive association between hope for success score and a person's cholesterol level.

No hypotheses as to nature of the correlation are made with respect to the fear of failure score and the composite scores because of the lack of linear relationships.

The hypotheses concerning the relationships between the indicators of actual achievement and the biochemical variables remain unchanged.

# CHAPTER IV

## RESULTS

### Relationship between the Achievement Orientation Index, the Physiological Measures of Uric Acid and Cholesterol, and Actual Achievement

There were a number of reasons that endangered the success of this study. We have already seen that the Heckhausen test of need achievement did not seem to assess what it purports to measure, and that the results with the Atkinson system are equally inconclusive. Furthermore, there was the unavoidable time lag between the assessment of a man's motivation and the time blood was drawn. And considering the relationship between the motivation scores and indicators of actual achievement there is the question whether a contemporary measure of motivation should be expected to be related to indicators of achievement that span all of a man's career.

For this reason it was very essential for us to replicate the early findings of Brooks and Mueller (1966). If this index also failed to yield any results, the conclusion would have to be drawn that the study contained too much distorting error variance for meaningful interpretation. On the other hand, if the replication of the earlier measures yielded substantially the same results, then the source of the error was narrowed down and interpretation could proceed from a safe ground of secure findings. Fortunately, the replication was successful. The data are presented in Table 27.

TABLE 27

CORRELATION BETWEEN THE ACHIEVEMENT ORIENTATION RATING, THE PHYSIOLOGICAL MEASURES, AND THE INDICES OF ACTUAL ACHIEVEMENT

| | Total Sample | | |
|---|---|---|---|
| | N | r | Significance |
| Relationship between achievement orientation rating and: | | | |
| Serum urate level | 102 | 0.50 | $p < 0.01$ |
| Serum cholesterol level | 76 | -0.12 | N.S. |
| Rate of progression* | 95 | 0.24 | $p < 0.05$ |
| Scholarly productivity | 86 | 0.29 | $p < 0.05$ |

*Coefficient reversed for easier reading of the table. High serum urate level is now associated with a fast rate of progression.

While the correlation between serum urate level and achievement oriented behavior rating is smaller than in the previous study (Brooks & Mueller, 1966) where the correlation was r = 0.66, the results are still a highly respectable replication. The lower coefficient in this study is easily explained by the fact that this time only one scorer's ratings were used thus losing the error check that was possible in the original study which used two raters. That there is no significant relationship between uric acid and cholesterol (r = 0.07) is in keeping with other findings reported in the literature (Mueller et al., 1970).

The correlation between the achievement orientation rating and the measures of actual achievement can be viewed as a kind of validation. The significance of the coefficients indicates that the behavioral characteristics rated are indeed related to actual achievement, independently assessed. However, the low level of the coefficients should also be noted. We take it to indicate that advancement in one's chosen field, and degree of productivity are dependent on many factors, only one of which is the achievement orientation of the person himself.

Table 28 compares the subscore correlations in the two studies for further clarification of the comparability of the results.

TABLE 28

CORRELATION BETWEEN URIC ACID LEVEL AND SUBSCORES OF THE
ACHIEVEMENT ORIENTATION MEASURES IN THIS STUDY
AND AN EARLIER ONE*

| | Present Study | | Brooks/Mueller, 1966 | |
|---|---|---|---|---|
| | N | r | N | r |
| Total behavior score | 102 | 0.50 | 51 | 0.66 |
| Drive | 102 | 0.43 | 51 | 0.57 |
| Achievement | 102 | 0.26 | 51 | 0.54 |
| Leadership | 102 | 0.34 | 51 | 0.54 |
| Pushing of self | 102 | 0.11 | 51 | 0.43 |
| Range of activities | 102 | 0.23 | 51 | 0.51 |
| Attitude towards pressure | 102 | 0.23 | 51 | 0.12 |
| Emphasis on research | 102 | 0.22 | 51 | 0.19 |

*Brooks & Mueller, 1966.

### Relationship between the Physiological Variables and the Various Tendencies of the Motivation to Achieve

In its revised form, the central new hypothesis of this study states that there will be a negative relationship between the hope for success score and the person's serum urate level. The rationale for this hypothesis is the assumption that uric acid is associated with positive, success-oriented striving, and that the hope for success score indicates concern over lack of positive achievement. Since fear of failure did not seem to linearly relate to other variables, we gave up the predictions made previously with respect to the other motivational tendencies. Table 29 shows that this hypothesis cannot be considered confirmed by the usual standards of significance.

However, it does seem noteworthy to point to the differences in the relationship between the status groups, especially between assistant and associate professors. The difference between $r = -0.24$ and $r = +0.38$ is statistically significant ($z = 2.13$, $p < 0.05$). Table 29 presents the data, breaking down the sample by status groups.

TABLE 29

CORRELATION BETWEEN SERUM URATE LEVEL AND THE VARIOUS TENDENCIES OF ACHIEVEMENT MOTIVATION IN THE VARIOUS STATUS GROUPS AND THE TOTAL SAMPLE OF PROFESSORS

| Motivational Tendency | Total N = 100 | Assistant N = 23 | Associate N = 21 | Full N = 39 | Administrator N = 17 |
|---|---|---|---|---|---|
| Total motivation | -0.01 | -0.23 | 0.27 | 0.06 | -0.13 |
| Net hope | 0.00 | -0.16 | 0.12 | 0.00 | 0.15 |
| Hope for success | 0.03 | -0.24 | 0.38 | 0.04 | 0.04 |
| Fear of failure | -0.05 | -0.09 | -0.04 | 0.07 | -0.18 |
| n. ach. | 0.08 | 0.00 | 0.47* | 0.07 | -0.34 |

*Coefficients significant at the 5% level or better are underlined.

The relationship between the Atkinson n. ach. score and uric acid in the two status groups, assistant and associate professors, tends to show the same difference, although not quite as strongly ($z = 1.70$, $p > 0.05$). On the other hand, among the associate professors the relationship between n. ach. score and uric acid is significantly positive.

In other words, it seems as if the test scores have different meanings for men at different status levels. Assuming our hypothesis to be correct, then this would mean that in assistant professors the hope for success and the n. ach. scores tend to express concern over lack of achievement, while among associate professors the scores tend to reflect motivation. At the moment, we find it difficult to interpret this finding. It would be reasonable to assume that tenure makes the difference in some way. But then full professors should show the same tendency which cannot really be maintained considering the virtually zero coefficients between uric acid and test scores in this group.

The prediction made with respect to cholesterol is the exact opposite to that for uric acid. The hypothesis states that serum cholesterol level should be positively associated with the hope for success score understood as an expression of concern over lack of achievement. Table 30 presents the data.

TABLE 30

CORRELATION BETWEEN SERUM CHOLESTEROL LEVEL AND THE VARIOUS TENDENCIES OF ACHIEVEMENT MOTIVATION IN THE VARIOUS STATUS GROUPS AND THE TOTAL SAMPLE

| Motivational Tendency | Total N = 78 | Assistant N = 21 | Associate N = 19 | Full N = 27 | Administrator N = 11 |
|---|---|---|---|---|---|
| Total motivation | -0.13 | 0.00 | -0.47 | 0.12 | -0.53 |
| Net hope | 0.25* | 0.40 | 0.36 | 0.12 | -0.25 |
| Hope for success | 0.07 | 0.31 | -0.13 | 0.18 | -0.75 |
| Fear of failure | -0.29 | -0.35 | -0.56 | -0.06 | -0.07 |
| n. ach. | -0.09 | 0.00 | -0.13 | -0.18 | -0.42 |

*Underlined coefficients are significant at the 5% level or better.

Again it can be said that the concern-hypothesis finds some support in the group of assistant professors, and certainly it can be said that academic administrators and assistant professors are not drawn from the same universe of meaning with respect to the scores on the Heckhausen test. Why in this case the big difference found between the assistant professors and the academic administrators, we are unable to explain. It is unlikely to be the fact of tenure. The relationship between cholesterol and hope for success score among full professors speaks against this interpretation.

## Relationship between the Physiological Variables and the Indices of Actual Achievement

Since we hypothesize that serum uric acid is linked to a person's achievement level, even though we are still unclear about the intervening links, we would expect a positive relationship between uric acid and indices of actual achievement. Since we view cholesterol level as an indicator of psychological strain, we would hypothesize that there will be a positive association between cholesterol level and psychological strain. But we are not able to say beforehand whether high or low achievement will be more strain producing. Each can do so, low achievement being related to the strain of qualitative overload, while high achievement tends to be associated with quantitative overload and its corresponding strain (French et al., 1965). The data for the total sample and the various status groups are presented in Table 31.

TABLE 31

CORRELATION BETWEEN THE PHYSIOLOGICAL VARIABLES AND THE INDICES OF ACTUAL ACHIEVEMENT

| Relationship | Total N | Total r | Assist. N | Assist. r | Assoc. N | Assoc. r | Full N | Full r | Administr. N | Administr. r |
|---|---|---|---|---|---|---|---|---|---|---|
| SUA/Progression | 95 | .00 | 22 | .01 | 19 | .20 | 37 | -.05 | 17 | -.20 |
| Cholesterol/ Progression | 79 | .25* | 21 | .31 | 17 | .31 | 30 | -.19 | 11 | -.52 |
| SUA/Productivity | 86 | -.17 | 21 | .33 | 19 | -.28 | 32 | -.21 | 14 | -.53 |
| Cholesterol/ Productivity | 72 | -.18 | 20 | .28 | 16 | -.45 | 27 | -.42 | 9 | -.18 |

*Underlined coefficients significant at better than the 0.05 level.

It seems advisable to correct these data for age effects. While there are no overall age effects, these are hidden due to the great differences in means among the status groups. Within the status groups the correlation between age and other variables is considerable as can be seen from Table 32.

TABLE 32

RELATIONSHIP BETWEEN URIC ACID, CHOLESTEROL, RATE OF PROGRESSION, PRODUCTIVITY AND AGE IN THE TOTAL SAMPLE AND THE VARIOUS STATUS GROUPS

| Relationship | Total N | Total r | Assist. N | Assist. r | Assoc. N | Assoc. r | Full N | Full r | Administr. N | Administr. r |
|---|---|---|---|---|---|---|---|---|---|---|
| SUA/Age | 118 | -.05 | 26 | .04 | 28 | .08 | 46 | -.15 | 18 | -.49* |
| Cholesterol/Age | 92 | .07 | 23 | .37 | 25 | .37 | 32 | .13 | 12 | .22 |
| Progression/Age | 105 | .00 | 24 | .74 | 23 | .92 | 41 | .43 | 17 | .16 |
| Productivity/Age | 95 | .04 | 23 | -.24 | 22 | -.61 | 36 | -.13 | 14 | .12 |

*Underlined coefficients are significant at the 5% level of better.

From the above table it can be seen that within the status groups age does play a role. Therefore, we decided to correct for age. The age corrected data are presented in Table 33. The data were corrected by partialling out the effect of age (Guilford, 1956).

## TABLE 33

## CORRELATION BETWEEN THE PHYSIOLOGICAL VARIABLES AND THE INDICATORS OF ACTUAL ACHIEVEMENT CORRECTED FOR THE INFLUENCE OF AGE

| Relationship | Total |  | Assist. |  | Assoc. |  | Full |  | Administr. |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  | N | r | N | r | N | r | N | r | N | r |
| SUA/Progression | 95 | .00 | 22 | -.03 | 19 | .33 | 37 | .02 | 17 | -.13 |
| Cholesterol/ Progression | 79 | .26* | 21 | .06 | 17 | -.08 | 30 | -.25 | 11 | -.56 |
| SUA/Productivity | 86 | -.17 | 21 | .37 | 19 | -.29 | 32 | -.24 | 14 | -.47 |
| Cholesterol/ Productivity | 72 | -.19 | 20 | .40 | 16 | -.31 | 27 | -.45 | 9 | -.21 |

*Underlined coefficients significant at better than the 0.05 level.

As can be seen, there is no consistent relationship between a person's serum urate level and his rate of progression. On the other hand, there is an interesting relationship between cholesterol and rate of progression. While overall the finding confirms our view that slow rate of promotion is experienced as strainful resulting in higher serum cholesterol values, there is a progressively stronger trend in the opposite direction within the status groups. In other words, while overall those in the higher status levels tend to have lower cholesterol levels, and also tend to have made faster progress, an additional factor comes into play within each group indicating that those who are making above average progress as compared to the rest of their peer group are subject to additional strains. The most reasonable explanation seems to involve the concepts of quantitative and qualitative overload (French et al., 1965). While slow promotion tends to be experienced as qualitative overload, as the feeling of not being good enough, the attempt to progress faster than one's peer group leads to quantitative overload, the feeling of having too much to do. Both strains may lead to elevated cholesterol levels, even though their psychological meaning is quite different. This interpretation is fostered by the fact that the significant correlation between cholesterol and rate of progression disappears if rate of progression is not measured in number of years at each status step, but as z-scores expressing the above or below peer group average rate of promotion. By peer group we mean in this case the person's status group. The correlation between rate of progression expressed as z-score and cholesterol is r = 0.07.

The interesting finding about the relationship between the physiological variables and productivity is the pattern of relationship which much clearer than before points to a difference between assistant professors on the one hand and all other status groups on the other hand. To better bring out this pattern we divided the sample into two groups: tenure and non-tenured professors, i.e., assistant professors in one group, all others combined in the second group. The correlation coefficients in the larger group were averaged (Guilford, 1956). The data are presented in Table 34. The last column of Table 34 gives the significance of the difference between the correlation coefficients in the two groups (Guilford, 1956).

TABLE 34

AGE-CORRECTED CORRELATION BETWEEN THE PHYSIOLOGICAL VARIABLES AND THE INDICES OF ACTUAL ACHIEVEMENT IN THE TENURED AND NON-TENURED PROFESSORS

| Relationship | Non-Tenured | | Tenured | | Significance of the difference |
|---|---|---|---|---|---|
| | N | r | N | r | |
| SUA/Productivity | 21 | 0.37 | 65 | -0.31 | $z = 2.65, p < 0.01$ |
| Cholesterol/Productivity | 20 | 0.40 | 56 | -0.38 | $z = 2.94, p < 0.01$ |

In interpreting Table 34 we turn to uric acid first. We see that there does exist the expected relationship in the non-tenured group of the assistant professors. Here, those with a higher number of publications are also those with the higher uric acid levels. But this expected trend is significantly reversed in the tenured personnel. Here, those with the higher levels of uric acid in the serum have the lower scholarly productivity. If, in the face of these data, we want to maintain the idea that uric acid is related to occupational achievement, then the only solution is the assumption that occupational achievement means one thing for those at the beginning of their careers, without tenure, and another thing for those with tenure. For the young man, achievement does seem to mean scholarly productivity, while it does not seem to mean this in the higher ranks. We will have occasion to say more to this point later on. Here we want to point out that if we look over Table 33 we see the relationship between uric acid and productivity is most strongly negative among the academic administrators for whom as we know from previous studies (French et al., 1965) scholarly productivity is less a criterion of success than keeping up with the work load.

In order to understand the relationship between cholesterol and productivity, we have to review some findings of an earlier study (French et al., 1965): we know from that study that qualitative overload, the feeling of not being up to the demands of the job, is greater in the non-tenured than the tenured group of professors, and that this feeling decreases as a man moves up the ladder of promotion. Thus, by dichotomizing we have created two groups, one for which qualitative overload is a relevant factor of their occupational lives, and another group for which this kind of strain is of reduced significance. Furthermore, the correlation between scholarly productivity and the speed with which a young man reaches tenure is $r = 0.58$ ($p < 0.01$). In other words, we have two findings which complement each other: Productivity leads to tenure and thus reduction of qualitative overload, but productivity also leads to increased cholesterol level which we want to interpret as a sign of strain. This as we just said isn't qualitative job strain that is associated with high productivity, high cholesterol levels in the younger group is the correlate of producing, of quantitative overload, the feeling of having too much to do. Those who produce a lot will be more subject to such strain and consequently should show increased levels of serum cholesterol. At the tenure level, however, not producing, while no impediment to fast progress, is associated with higher levels of cholesterol which is quite understandable considering the prevailing norm of producing scholarly articles. Consultation, committee work, or administration can explain the lack of productivity, and seem to be recognized as substitutes in the case of final promotion, but that does not invalidate the norm. Thus, for those at the higher levels who aren't producing, there remains that nagging feeling that they really should produce more. And it seems quite conceivable and plausible that this is the kind of strain to influence a person's serum cholesterol level. This interpretation is somewhat supported by the fact that the negative relationship between productivity and cholesterol is strongest in the full professors, and is relatively weakest in the academic administrators among whom the productivity norm is by the nature of their job less salient. The relationship between uric acid and productivity among academic administrators is consistent with this interpretation. We interpreted the relationship between uric acid and productivity by assuming that productivity is less of a success criterion at the higher, tenured levels. The group for whom we know scholarly productivity to be less relevant is the group of administrators. And indeed we find that in this group the correlation between serum urate level and productivity is most strongly negative.

To summarize: Our interpretation of the relationship between cholesterol and the indices of actual achievement in the two groups assumes the existence of two kinds of strain, roughly equated with qualitative and quantitative overload, both related to cholesterol. Both kinds of strain are present at all occupational levels but in differing degrees of relevance in that a high rate of scholarly productivity is at the non-tenure level associated with quantitative overload while a low rate of productivity at the tenure level is associated with qualitative overload. Unfortunately, this interpretation must remain hypothetical since we don't have the measures of psychological strain in this study, and are, therefore, unable to put our interpretation on firmer ground.

The data further indicate that "rate of progression" is either too multifaceted a concept to be clearly related to serum uric acid, or it may be that our way of assessing rate of progression does not take sufficient account of the special circumstances, that can either delay or accelerate advancement in a way that is unrelated to a person's own achievement striving. On the other hand, productivity seems to be better suited as a measure for showing associations between uric acid and achievement, at least at those occupational levels at which productivity is seen as a sign of achievement. Unfortunately, the fact that at the higher levels of the academic hierarchy other criteria of "success" do seem to exist limits the applicability of this measure.

## Relationship between Actual Achievement and Work Load

In earlier sections we came to the conclusion that the criteria of success differ at the different status levels. We want to demonstrate this further by showing the relationships between the indicators of actual achievement and the number of hours the professor presently works in an average week. In the interpretation of the findings, we will use the number of hours a man presently works as the best available approximation to his lifelong, habitual work output, and we will use the index in this sense. Table 35 presents the relevant data. It might be pointed out that the results remain virtually unchanged, if we recompute the correlations using z-score measures expressing a man's achievements in terms of his relative standing within his status group.

TABLE 35

CORRELATION BETWEEN THE INDICATORS OF ACTUAL ACHIEVEMENT AND THE NUMBER OF WORK HOURS IN THE TOTAL SAMPLE AND THE VARIOUS STATUS GROUPS

| | Hours of Work and Rate of Progression | | Hours of Work and Productivity | | Productivity and Rate of Progression | |
|---|---|---|---|---|---|---|
| | N | r | N | r | N | r |
| Correlation between: | | | | | | |
| Assistant professors | 24 | -0.30* | 23 | -0.11 | 23 | 0.17 |
| Associate professors | 23 | 0.09 | 22 | 0.43** | 22 | 0.58 |
| Full professors | 41 | 0.34 | 36 | 0.19 | 36 | 0.00 |
| Academic administrators | 17 | -0.22 | 14 | 0.41 | 14 | 0.19 |
| Total sample | 105 | 0.06 | 95 | 0.25 | 95 | 0.27 |

*Signs reversed on all correlations involving "rate of progression." Positive correlation means the higher the value of the variable the faster the progression.

**Correlation coefficients significant at the 5% level or better are underlined.

For a clearer understanding of these findings it may be worthwhile to correct each relationship for the influence of the third variable, and to present the data in this fashion. Table 36 does exactly this. The data are corrected by partialling out the effects of the third variable (Guilford, 1956).

TABLE 36

CORRELATION BETWEEN THE INDICATORS OF ACTUAL ACHIEVEMENT AND THE NUMBER OF WORK HOURS IN THE TOTAL SAMPLE AND THE VARIOUS STATUS SUBGROUPS, EACH RELATIONSHIP CORRECTED FOR THE INFLUENCE OF THE THIRD VARIABLE ON THE RELATIONSHIP

| | Hours of Work and Rate of Progression | | Hours of Work and Productivity | | Productivity and Rate of Progression | |
|---|---|---|---|---|---|---|
| | N | r | N | r | N | r |
| Corrected correlation between: | | | | | | |
| Assistant professors | 24 | -0.29* | 23 | -0.06 | 23 | 0.14 |
| Associate professors | 23 | -0.22 | 22 | $\underline{0.47}$** | 22 | $\underline{0.60}$ |
| Full professors | 41 | $\underline{0.35}$ | 36 | 0.20 | 36 | -0.07 |
| Academic administrators | 17 | -0.33 | 14 | 0.47 | 14 | 0.32 |
| Total sample | 105 | -0.01 | 95 | $\underline{0.24}$ | 95 | $\underline{0.26}$ |

*Signs reversed on all correlations involving "rate of progression." Positive correlation means the higher the value of the variable the faster the progression.

**Correlation coefficients significant at the 5% level or better are underlined.

We see that the three variables rate of progression, productivity, and number of work hours are not related in any reliable fashion among assistant professors. If anything, there is a suggestion that those who work long hours need longer to become appointed assistant professors. When we assume for a moment that intelligence, or talent in general can to a certain extent make up for hard work, and vice versa, then one might venture the guess that the speed with which a man becomes assistant professor tends to depend more on his talents or the way others perceive his talents than on hard work.

Among associate professors the picture is different. There is no relationship between how hard a man works and how fast he moves up to tenure level. However, there is a significant relationship between rate of promotion and productivity in the sense of scholarly publications ($r = 0.60$, $p < 0.01$). And there also exists a sizeable relationship ($r = 0.47$, $p < 0.05$) between work output and productivity. In other words, hard work by itself has no effect on speed of promotion but only when the hours are expended in work that leads to scholarly publications since that seems to be the criterion for speedy promotion to tenure level. This becomes especially clear when we control the relationship between work hours and rate of promotion by the correlation of these two variables to productivity. Partialling out productivity changes the coefficient from r = 0.09 to r = -0.22, suggesting that work effort not expended toward the increase of scholarly productivity might actually be harmful for one's rate of promotion.

The picture changes again when we look at the group of full professors. Here there is again no relationship between work effort and productivity but also no relationship between productivity and rate of promotion. In other words, while it takes proof of scholarly productivity to make associate professor, the speed with which the man gets promoted to full professor does no longer seem to depend on his productivity. There is, however, in contrast to the other two status groups a significant correlation between the number of hours worked per week and the speed of promotion. Since in contrast to the associate professors this work effort is not related to the production of scholarly papers we suggest that it is work in areas other than scholarship that leads to quick progress to full professor.

We can only speculate about the relationships in the group of the administrators. The sample size is simply too small to make any reliable statements. It is, however, intriguing to see that the administrators who are virtually all full professors resemble in their pattern of relationships much more the associate professors than the full professors.

Summarizing we might say: A man is hired as assistant professor because of his "promise." In order to progress to associate professor he has to fulfill that promise by demonstrating scholarly productivity. Having demonstrated it, having passed the screen, so to speak, the effective criteria of promotion change away from scholarly productivity to other things that can be accomplished by hard work. We have no data on what these other areas might be but suggest that consulting, work in national organizations, in general, work that provides visibility in the field beyond the range of one's work peers might be the kind of work effort that pays off for the man who has passed the scholarship test by having been made associate professor. It needs to be pointed out, however, that this interpretation holds true only if we separate the academic administrators who are themselves full professors from the rest of the full professors, since the academic administrators seem to be a group whose speed of promotion up to the full professor level seems to have depended on productivity, and who seem to be concerned as were the associate professors with using their work effort toward increased productivity.

## CHAPTER V

## INTERPRETATIONS AND CONCLUSIONS

### Interpretation

Two results seem to stand out: (1) the successful replication of the finding that a multi-dimensional rating scale of achievement oriented behavior relates strongly to serum urate levels, and (2) the lack of strong evidence linking uric acid levels and the chosen indices of motivation and actual achievement.

The replication of the rating scale developed by Brooks and Mueller (1966) reaffirms the existence of the phenomenon, reassures us that even though we are not yet fully grasping the nature of it, there does exist a relationship between uric acid level in the serum and the realm of achievement. The proof that we are not yet understanding this relationship is uncomfortably demonstrated by the lack of confirmation of seemingly reasonable extensions of the original findings. That even the replication of the Brooks/Mueller rating scale in other hands (Anumonye et al., 1969) is less successful indicates, aside from all other reasons, that the original authors have not yet been able to fully conceptualize the meaning of the term "achievement orientation," and in failing to conceptualize it they are unable to communicate the full meaning of their understanding to others, and even to themselves as is indicated by the lack of confirmation in this study, and the one by Sales (1969) who writes:

> . . . in previous research (e.g., see Mueller, 1965), a strong positive correlation has been found between personality variables similar to those studied here and serum uric acid. In the present investigation, however, the relationship between the personality variables . . . and uric acid are generally negative . . . . The author's choice in this matter is to interpret the uric acid data as inconsistent with the data obtained by Mueller (1965) . . . [Sales, 1969, p. 56].

The same trend toward insignificant and even negative relationships was found in this study (e.g., see Table 29). One reason for this has already been mentioned above. The failure to confirm what clearly seemed direct extensions from previous studies (e.g., Brooks & Mueller, 1966; or Kasl et al., 1970) is seen as indicative of the imperfect state of our understanding of the essential variables involved in this relationship. It points out that we are still rather in the dark as to the appropriate dependent psychological state, e.g., whether it ought to be achievement oriented behavior, achievement motivation in general, or achievement motivation in the more specific sense of "hope for success." On the other hand, the lack of support also indicates that uric acid, so far presumed to be the causal biochemical agent may itself only be the imperfect indicator of other, still unknown processes.

But there is another reason, potentially more fruitful for future research, that should be discussed. It seems that in the same way in which McClelland (1958) feels that self-report measures of need for achievement are generally invalid predictors of actual achievement and performance, self-report measures of need for achievement also seem of doubtful validity as indicators of the psycho-social correlates of serum urate level. This notion that uric acid level is more related to behavior and indirect indices than to self-report measures is not a new one. Kasl et al. (1966) suggest:

> . . . the possibility that SUA levels are associated with behavioral indicators of achievement orientation and accomplishments rather than with self-reporting and "projective" measures of need for achievement [p. 716].

And again in their most recent study Kasl, Brooks, and Rodgers (1970) make the same comment when they write:

> In the present study we were able to confirm the general observation, made previously, that direct statements about various aspects of achievement orientation and motivation are less likely to relate to uric acid than are more behavioral indicators or more indirect measures [p. 37].

This argument can easily be applied to explain the findings in the study by Sales, aside from the fact that the statistically reliable sample Sales used consisted of college students not yet integrated into the work process while the positive results linking uric acid and achievement come predominantly from samples of men gainfully employed.

But should a TAT-like measure such as the one developed by the McClelland group and refined by Heckhausen show consistently similarly negative relationships between the motivation scores and the indicators of actual achievement? We feel that there is only one way to interpret the results meaningfully: by assuming that what was projected was not the state of the need for achievement but the degree to which this need was unmet, the degree to which the man was concerned with his lack of achievement. This view of the data would also offer a highly plausible explanation for the differences in the results of the German study (Mueller & Beimann, 1969) and the present one. It does not explain, of course, why the test in one group of subjects seems to reflect need for achievement, and in another group concern over unmet needs; even more, why one group of professors should project in its stories unmet need, while another group projects the actual state of the need (e.g., Chapter IV, Table 29).

To learn to distinguish between score patterns that reflect need and those that reflect unmet need would seem a research task of major methodological significance.

This kind of interpretation is, of course, only strengthened by the respectable replication of earlier hypotheses through the use of an indirect, interpreting measure of achievement striving. We refer to the achievement orientation scale based on the evaluation of the professor's statements in a lengthy job interview.

## Conclusions

If we take as a result of this study the renewed confirmation that serum urate levels seem related to indirect measures of achievement striving while self-report measures of even projective tests do not seem to correlate in a reliable fashion, then the question still remains what the implications of such findings are for future work in this area.

It seems to us that these results are fully consistent with Orowan's (1955) notion of uric acid as a stimulant of central nervous system functioning, i.e., an activating agent. According to Orowan's view, uric acid would affect a person's general, non-specific level of activation, making that person more alert, striving and active. Whether this increased level of activation leads to occupational achievement, however, will depend on the reward structure of the person's life space. If his social environment rewards occupational achievement, sets achievement norms, and punishes failure, then the general, non-specific activation will be channeled into this direction. On the other hand, if the social norms surrounding the person reward and demand, let us say, a high level of social skill, then the activation will be channeled into this direction. Here, by the way, could lie one of the reasons why studies involving women do not seem to yield the same results as studies using men as subjects. According to this view, a measure of achievement motivation would, and should show a relationship to uric acid only if achievement, specifically occupational achievement, is the area into which a person channels his energies.

One reason that behavior ratings and other indirect measures seem to yield better results than self-report and projective measures may lie in the fact that they are less achievement-specific. One may choose the occupational realm to rate "drive," understood as general level of energy output, as Brooks and Mueller (1966) do, but it is quite reasonable to expect that a variable that is so close to what earlier generations of psychologists have called "temperament" will find similar expressions in many areas of life so that even if uric acid is not directly linked to achievement it still will correlate with such a behavioral rating because of the behavioral measure's greater generality. Whether the energy output will crystalize into something as specific as "achievement motivation" will depend on more than just "temperament" but, as Rosen (1955) points out, on the learning experiences and the value structure of the individual as well. Kasl et al. (1970) seem aware of this problem when they write:

> Clearly, the first question (for future research) which needs to be raised is: What aspects of achievement (broadly defined) are related to uric acid, in what kind of populations, under what kind of circumstances? [p. 53].

We agree with this statement but feel that even broadly defined "achievement" is too narrow a correlate for uric acid, since we don't believe that "achievement" is the only correlate of activation. As long as we continue to restrict ourselves to searching for correlates in the achievement realm only, we are courting failure and lack of confirmation. It is our conclusion that further inductive research in the form of correlational studies is not the answer to such unconclusive findings. To use a metaphor, this method seems like hunting the fox by surrounding it with a lot of drivers instead of starting at the lair and following its trail. It can be done, but it seems highly inefficient, uncertain, and also inelegant, aside from the fact that such correlational studies still would not explain the demonstrated relationships in any causal way. Thus, we disagree with Kasl et al. (1970) who write:

> The only way to deal with this question (of what aspects of achievement are related to uric acid) is via an accumulation of correlational studies on diverse populations, in diverse settings, and using diverse measures . . . . With regard to measures of achievement, multiple operationism is clearly called for . . . . The important point is that in each setting the investigator must determine what are the achievement indicators most appropriate for the given situation, since what represents achievement for a college professor may vary greatly from those indicators that signal achievement to an executive or blue collar worker [p. 53].

We feel that given the practical limitations of time and resources in research this approach can only lead to a confusion of results which is likely to be disenchanting and discouraging to potentially interested researchers. This trend is expressed in an editorial in the Journal of the American Medical Association published in 1969:

> Another obstacle (to the complete acceptance of a meaningful relationship between desirable personality traits and serum uric acid level) is the lack of a convincing scientific explanation. Orowan attempted to explain the association by the stimulating effect of endogenous uric acid on the cerebral cortex. This hypothesis is yet to be confirmed. A valid answer to the "why" and "how" would add meaning and credibility to the impressive statistical data on the correlation of serum uric acid and the psyche [J.A.M.A., 1969, 208, p. 1180].

As a conclusion therefore, we propose an approach opposite from the one advocated by Kasl et al. (1970): not further inductive exploration of the domain but back-tracking to the point of meaningful theoretical links between serum urate levels and psychosocial correlates. In other words, we are advocating experimental research, raising and lowering serum urate levels, in order to test the only theory advanced so far linking uric acid to behavior, namely Orowan's notion that uric acid acts as an activating agent. In back-tracking to the relationship between uric acid and "activation" in the sense used by Moruzzi and Magoun (1949), Duffy (1962) or Schoenpflug (1967) we try to avoid restricting ourselves to the achievement area but to go back to the earlier links in the chain connecting uric acid and psychosocial correlates. If it can be shown that SUA is linked to energy output or "temperament," we can then go on and ask in what area of life does this person expand his energy, show his "temperament." And that realm of life should then be linked to the person's serum urate level.

This emphasis on psycho-physiological experimental research leads us to a last conclusion from the present study, and that is that progress in this area will probably not be forthcoming unless a group of medical researchers will develop interest in these relationships. It is beyond the feasibility of operation of an institute for social research to conduct such investigations. Within the setting of social research the experiments needed to answer the questions simply become too expensive. Facilities and skills which social researchers first need to develop are simply at hand in a good metabolic ward, for example. Even the dependent variables in such studies, reaction time, flicker fusion frequency etc. are more familiar to the physiologist than to the social scientist. As relative outsiders we were able to stimulate discussion by demonstrating the existence of psycho-physiological relationships in an area of immense potential relevance. However, the problem will remain unsolved unless it is taken up by competent researchers in a medical setting, with the facilities and the support staff to conduct such investigations efficiently.

We believe that our experiences in this line of research and with this study in particular can be used to illustrate the relationship of deductive and inductive research strategies in general. While earlier periods of science tended to draw rather sharp lines between an approach that seeks to deduce specific statements from more general ones, and the other strategy which tries to abstract comprehensive generalizations from specific instances, we now recognize these approaches as differing in emphasis only. We realize that pure speculation without reference to observable facts of nature is sterile and irrelevant for solution of concrete problems in the social sciences, while on the other hand, given the complexity of nature, "true" induction is impossible since we will always approach the world with a preformed system of concepts which function as hypotheses and also impose on nature a structure not necessarily its own, or for that matter, the only structure possible. Amsel (1965) uses a very persuasive illustration. Take the example of a child's puzzle, he says, in which numbered points are to be connected to form the outline of an object or an animal. If we have the points, and have the numbers, we can formulate a "theory" that might read: Connecting all numbers in sequence by straight lines will yield the required outline. This case, of course, is simple but Amsel continues:

> Now let us change the game a bit. The page is now, not a scattering of isolated dots with numerals next to them, but a page almost black with dots. Only some of these dots outline the pattern which is hidden, and there are no numerals at all to guide the joining of these critical points. But you still have to find the hidden animal by joining dots. You don't know how many dots to join, or where they are on the page. Your task is complicated by the fact that in order to outline the hidden animal you must first find the points in the total complex of points that are relevant (have a number) and then find what number each point has [1965, p. 187].

This is the problem of induction. But since it is more than likely impossible to observe and investigate all possible events and relationships, the question then becomes when in the process of inquiry do you formulate a theory about the nature of the events, deducing in turn from that theory further meaningful and relevant events. To use deductive reasoning, model-building too early in the investigation can be stifling. Premature experimentation can be narrowing to the point where the problem loses completely its character of a full-fledged phenomenon of everyday life, and becomes an exercise in experimental ingenuity, an etude at best. The attempts to assess the "success" of psychoanalysis in changing personality by looking at the before and after scores on personality inventories is one example of such premature rigor, of introducing rigor at a time when not at all enough is known about the meaning of "success" in therapy, the relationship of therapy to behavior changes, and the nature of therapy itself. Another example is the attempt to "justify" the use of a projective test by relating single indices derived from the projections to scores on other personality tests. This too is premature, since not enough is known about the process of projection itself, and because there are in many cases, on the one hand, no test equivalents for the complex concepts the projective measure attempts to assess, while,on the other hand, the theory of multi-dimensional scaling is not yet developed enough to permit the reconstruction of a gestalt from its component parts. Therefore, at such an early stage, correlational studies, detailed reports of individual case histories, and epidemiological studies as well as studies approaching the phenomenon in the shotgun approach of multiple operationism advocated by Kasl et al. (1970) is quite in order and the appropriate way to go. And if there is any validity to the phenomenon this approach will yield results, ideally leading to some kind of conceptual validation by slowly building a construct out of the multifaceted individual results.

Unfortunately, things usually don't work out that well expecially not in the area of psychosomatics where the chain between presumed causative agent and dependent variable has a great number of links only few of which can be assessed in any given study. Thus, it is more likely that confusion will arise, since problems have the nasty habit of growing in complexity the more one studies them. Inconclusive and even contradictory results are more likely to occur. And while Kaufmann (1968) writes "that there is no uniquely valid cut-off point at which induction must end or deduction begin," we feel that it would be a good rule of thumb to choose this point of confusion as a cut-off point. It is precisely at this point of confusion, it seems to us, that the method of induction becomes useless, costly, and wasteful. Since one doesn't any longer exactly know what to look for, nor often how to measure that which one is looking for, results often become uninterpretable, since it becomes extremely difficult to decide between alternatives; whether a given inconclusive finding is: (1) due to the fact that no relationship exists; (2) the concept was insufficiently operationalized; or (3) random errors in the investigation have to be blamed. To take an example from this study: Is there a lack of relationship between hope for success and uric acid because the two are not related, because the Heckhausen test does not tap hope for success as it claims to, or because in this particular group conditions exist which render the test useless for these subjects? But unless one can decide whether a finding is a true result, an error in reasoning, or a random error further progress becomes simply a matter of chance.

72

Thus, we feel that whenever a line of research after initial success runs into this kind of confusion, it is time to leave the "context of discovery," to use Reichenbach's (1953) term, and to change to the "context of justification," i.e., to shift one's strategy from inductive, data gathering, correlational studies to the deductive, if possible experimental, investigation of that theory, however tentative, that best fits the most striking findings. Should it happen, however, that this approach too leads to naught, then we feel the researcher has reached his limit and is best advised to drop the problem leaving it for those who can tackle it with fresh ideas and new approaches. Not only will this result in a more efficient and economical use of scientific resources and manpower, but it is also a way of protecting the mental health of the researcher, saving him from that occupational hazard of scientists--depression.

# REFERENCES

Abell, L. L., Levy, B. B., Brodie, B. B., & Kendall, F. E. A simplified method for the estimation of total cholesterol in serum and demonstration of its specificity. *Journal of Biological Chemistry*, 1952, *195*, 357-364.

Acheson, R. M., & O'Brien, W. M. Dependence of serum uric acid on hemoglobin and other factors in the general population. *Lancet*, 1966, *2*, 777-778.

Acheson, R. M., & O'Brien, W. M. Some factors associated with serum uric acid in the New Haven survey of joint disease. In P. Bennett & P. H. N. Wood (Eds.), *Population Studies of the Rheumatic Diseases*. New York: Excerpta Medica Foundation, 1968.

Altus, W. D. Birth order and its sequelae. *Science*, 1966, *151*, 44-49.

Amsel, A. On inductive versus deductive approaches and neo-Hullian behaviorism. In B. Wolman & E. Nagel (Eds.), *Scientific Psychology: Principles and Approaches*. New York: Basic Books, Inc., 1965.

Anonymous. Which comes first--success or gout? (Editorial) *Journal of the American Medical Association*, 1963, *185*, 534-535.

Anumonye, A., Dobson, J. W., Oppenheim, S., & Sutherland, J. S. Plasma uric acid concentrations among Edinburgh business executives. *Journal of the American Medical Association*, 1969, *208*, 1141-1144.

Atkinson, J. W. *An Introduction to Motivation*. Princeton, N.J.: D. Van Nostrand, 1964.

Atkinson, J. W. Motivational determinants of risk-taking behavior. *Psychological Review*, 1957, *64*, 359-372.

Atkinson, J. W. (Ed.) *Motives in Fantasy, Action and Society*. Princeton, N.J.: D. Van Nostrand, 1958.

Atkinson, J. W., & Feather, N. T. (Eds.) *A Theory of Achievement Motivation*. New York: Wiley, 1966.

Bell, J., & Stokes, W. *Lectures on the Theory and Practice of Physics*. Philadelphia: Barrington & Haswell, 1848.

Bennett, P. H., & Burch, T. A. Serum uric acid and gout in Blackfeet and Pima Indians. In P. H. Bennett & P. H. N. Wood (Eds.), *Population Studies of the Rheumatic Diseases*. New York: Excerpta Medica Foundation, 1968.

Bennett, P. H., & Wood, P. H. N. (Eds.) *Population Studies of the Rheumatic Diseases*. New York: Excerpta Medica Foundation, 1968.

Blumberg, B. S. Heredity of gout and hyperuricemia. *Arthritis and Rheumatism*, 1965, *8*, 627-647.

Boyle, J. A., Greig, W. R., Jasani, M. K., Duncan, A., Diver, M., & Buchanan, W. W. Relative roles of genetic and environmental factors in the control of serum uric acid levels in normouricaemic subjects. *Annals of Rheumatic Diseases*, 1967, *26*, 234-238.

Brooks, G. W., & Mueller, E. F. Serum urate concentrations among university professors. *Journal of the American Medical Association*, 1966, *195*, 415-418.

Bywaters, E. G. L., & Holloway, V. P. Measurement of serum uric acid in Great Britain in 1963. *Annals of Rheumatic Diseases*, 1964, *23*, 236-239.

Cadogan, W. A dissertation on the gout and all chronic diseases jointly considered. (10th ed.) Boston: H. Knox, 1772. (Republished: New York, P. B. Hoeber, 1925.)

Cameron, D. E., & Solyom, L. Effects of ribonucleic acid on memory. *Geriatrics*, 1961, *16*, 74-81.

Cameron, D. E., Sved, S., Solyom, L., Wainrib, B., & Barik, H. Effects of ribonucleic acid on memory defects. *American Journal of Psychiatry*, 1963, *120*, 320-325.

Caplow, T., & McGee, R. J. *The Academic Marketplace*. New York: Basic Books, 1958.

Cartter, A. M. *An Assessment of Quality in Graduate Education*. Washington, D. C.: American Council on Education, 1966.

Cattell, R. B. *Personality and Motivation. Structure and Measurement*. New York: World Book Co., 1957.

Cobb, S. Hyperuricemia in executives. In M. R. Jeffrey & J. Ball (Eds.), *The Epidemiology of Chronic Rheumatism*. Vol. 1. Oxford: Blackwell, 1963.

Cobb, S. *The Frequency of Rheumatic Diseases*. Cambridge: Harvard University Press, 1969.

Cobb, S., Dunn, J. P., Brooks, G. W., & Rodnan, G. P. Serum urate levels in males by social class. *Arthritis and Rheumatism*, 1961, *4*, 412. (Abstract)

Cobb, S., & French, J. R. P., Jr. Birth order among medical students. *Journal of the American Medical Association*, 1966, *195*, 312-313.

Copeman, W. S. C. A Short History of Gout. Berkeley: University of California Press, 1964.

Cowdrey, S. C. Hyperuricemia in infectious mononucleosis. Journal of the American Medical Association, 1966, 196, 319-321.

Decker, J. L., Lane, J. J., & Reynolds, W. E. Hyperuricemia in a male Filipino population. Arthritis and Rheumatism, 1962, 5, 144-155.

Demartini, F. E. Hyperuricemia induced by drugs. Arthritis and Rheumatism, 1965, 8, 823-829.

Dodge, H. J., & Mikkelsen, W. M. The relationship of serum uric acid scores to occupation, smoking and drinking habits in Tecumseh, Michigan, 1959-1960. Paper presented at the meeting of the American Public Health Association, Epidemiology Section, New York, October 1964.

Dreyfuss, F., & Czaczkes, J. W. Blood cholesterol and uric acid of healthy medical students under stress of examination. Archives of Internal Medicine, 1959, 103, 708-711.

Duff, I. F., Mikkelsen, W. M., Dodge, H. J., & Himes, D. S. Comparison of uric acid levels in some Oriental and Caucasian groups unselected as to gout or hyperuricemia. Arthritis and Rheumatism, 1968, 11, 184-190.

Duffy, E. Activation and Behavior. New York: Wiley, 1962.

Dunn, J. P., Brooks, G. W., Mausner, J., Rodnan, G. P., & Cobb, S. Social class gradient of serum uric acid levels in males. Journal of the American Medical Association, 1963, 185, 431-436.

Dunn, J. P., & Moses, C. Correlation of serum lipids with uric acid and blood sugar in mormal males. Metabolism, 1965, 14, 788-792.

Editorial. Uric acid and the psyche. Journal of the American Medical Association, 1969, 208, 1180.

Ellis, H. A Study of British Genius. London: Hurst & Blackett, 1904.

Essman, W. B. Purine metabolism in memory consolidation. Paper presented at the convention of the American Association for the Advancement of Science, Section on Medical Sciences, New York, December 1967.

Evans, J. G., & Prior, I. A. M. Relation of serum uric acid to body bulk, haemoglobin, and alcohol intake in two South Pacific Polynesian populations. Annals of the Rehumatic Diseases, 1968, 27, 319-325.

Feather, N. T. The relationship of persistence at a task to expectation of success and achievement-related motives. Journal of Abnormal and Social Psychology, 1961, 63, 552-561.

Feather, N. T. The study of persistence. *Psychological Bulletin*, 1962, *59*, 94-115.

Finn, R., Jones, P. O., Tweedle, M. C. K., Hall, S. M., Dinsdale, O. F., & Bourdillon, R. E. Frequency-distribution curve of uric acid in the general population. *Lancet*, 1966, *2*, 185-187.

Florey, C. D., & Acheson, R. M. Serum uric acid in United States and Brazilian military recruits, with a note on ABO blood groups. *American Journal of Epidemiology*, 1968, *88*, 178-188.

French, J. G., Dodge, H. J., Kjelsberg, M. O., Mikkelsen, W. M., & Schull, W. J. A study of familial aggregation of serum uric acid levels in the population of Tecumseh, Michigan, 1959-1960. *American Journal of Epidemiology*, 1967, *86*, 214-224.

French, J. R. P., Jr., Tupper, C. J., & Mueller, E. F. Work load of university professors. (Cooperative Research Project No. 2171) Ann Arbor: University of Michigan, 1965.

Gerard, R. W. The nosology of schizophrenia: A cooperative study. *Behavioral Science*, 1964, *9*, 311-333.

Gertler, M. M., Garn, S. M., & Levine, S. A. Serum uric acid in relation to age and physique in health and in coronary heart disease. *Annals of Internal Medicine*, 1951, *34*, 1421-1431.

Gordon, K. K., & Gordon, R. E. Birth order, achievement, and blood chemistry levels among college nursing students. Unpublished manuscript, 1968.

Gordon, R. E., Lindeman, R. H., & Gordon, K. K. Some psychological and biochemical correlates of college achievement. *Journal of the American College Health Association*, 1967, *15*, 326-331.

Grayzel, A. I., Liddle, L., & Seegmiller, J. E. Diagnostic significance of hyperuricemia in arthritis. *New England Journal of Medicine*, 1961, *265*, 763-768.

Gresham, G. E. Hyperuricemia--an epidemiologic review. *Archives of Environmental Health*, 1965, *11*, 863-870.

Guilford, J. P. *Fundamental Statistics in Psychology and Education*. New York: McGraw-Hill, 1956.

Gutman, A. B. The biological significance of uric acid. *Harvey Lecturer*, 1964-1965, *60*, 35-55.

Gutman, A. B., & Yü, T. F. Uric acid metabolism in normal men and primary gout. *New England Journal of Medicine*, 1965, *273*, 252-260. (a)

Gutman, A. B., & Yü, T. F. Uric acid metabolism in normal man and in primary gout (concluded). *New England Journal of Medicine*, 1965, *273*, 313-321. (b)

Haldane, J. B. S. Origin of man. Nature, 1955, 176, 169-170.

Hall, A. P. Correlations among hyperuricemia, hypercholesterolemia, coronary disease and hypertension. Arthritis and Rheumatism, 1965, 8, 846-852.

Hall, A. P., Barry, D. E., Dawbes, T. R., & McNamara, P. M. Epidemiology of gout and hyperuricemia. American Journal of Medicine, 1967, 42, 27-37.

Hauge, M., & Harvald, B. Heredity in gout and hyperuricemia. Acta Medica Scandinavica, 1955, 152, 247-257.

Healey, L. A., Caner, J. E. Z., Bassett, D. R., & Decker, J. L. Serum uric acid and obesity in Hawaiians. Journal of the American Medical Association, 1966, 196, 152-153.

Heckhausen, H. Hoffnung und furcht in der leistungsmotivation. Meisenheim/Glan: Anton Hain, 1963.

Henry, R. J. Clinical Chemistry, Principles and Technics. New York: Harper & Row, 1964.

Horvath, G. Blood-serum level of uric acid in top sportsmen. Acta Rheumatologica Scandinavica, 1967, 13, 308-312.

Jensen, J., Blankenhorn, D. H., Chin, H. P., Sturgeon, P., & Ware, A. G. Serum lipids and serum uric acid in human twins. Journal of Lipid Research, 1965, 6, 193-205.

Kasl, S. V., Brooks, G. W., & Cobb, S. Serum urate concentrations in male high school students, a predictor of college attendance. Journal of the American Medical Association, 1966, 198, 713-716.

Kasl, S. V., Brooks, G. W., & Rodgers, W. L. Serum uric acid and cholesterol in achievement behavior and motivation: Part I. Journal of the American Medical Association, 1970, 213, 1158-1164. (a)

Kasl, S. V., Brooks, G. W., & Rodgers, W. L. Serum uric acid and cholesterol in achievement behavior and motivation: Part II. Journal of the American Medical Association, 1970, 213, 1291-1299. (b)

Kasl, S. V., Cobb, S., & Brooks, G. W. Changes in serum uric acid and serum cholesterol in men undergoing job loss. Journal of the American Medical Association, 1968, 206, 1500-1507.

Kasl, S. V., & French, J. R. P., Jr. The effects of occupational status on physiological and mental health. Journal of Social Issues, 1962, 18, 67-89.

Kaufmann, H. Introduction to the Study of Human Behavior. Philadelphia: W. B. Saunders, 1968.

Keilin, J. Biological significance of uric acid and guanine excretion. Biological Review, 1959, 34, 265-296.

Kobler, J. My bout with gout. Saturday Evening Post, 1962, 235, 87-88.

Kral, V. A., Solyom, L., & Enesco, H. E. Effect of short-term oral RNA therapy on the serum uric acid level and memory function in senile versus senescent subjects. Journal of the American Geriatrics Society, 1967, 15, 364-372.

Krizek, V. Serum uric acid in relation to body weight. Annals of the Rheumatic Diseases, 1966, 25, 456-458.

Lanese, R. R., Gresham, G. E., & Keller, M. D. Behavioral and physiological characteristics in hyperuricemia. Journal of the American Medical Association, 1969, 207, 1878-1882.

Lecocq, F. R., & McPharl, J. J. The effects of starvation, high fat diets and ketone infusion on uric acid balance. Clinical Research Proceedings, 1964, 12, 274.

Lesch, M., & Nyhan, W. L. A familial disorder of uric acid metabolism and central nervous function. American Journal of Medicine, 1964, 36, 561-570.

Liddle, L., Seegmiller, J. E., & Laster, L. The enzymatic spectrophotometric method for determination of uric acid. Journal of Laboratory and Clinical Medicine, 1959, 54, 903-913.

Lieber, C. S. Hyperuricemia induced by alcohol. Arthritis and Rheumatism, 1965, 8, 786-791.

MacLachlan, M. J., & Rodnan, G. R. Effects of food, fast and alcohol on serum uric acid and acute attacks of gout. American Journal of Medicine, 1967, 42, 38-57.

Mandler, G., & Sarason, S. B. A study of anxiety and learning. Journal of Abnormal and Social Psychology, 1952, 47, 166-173.

Mann, F. C. Towards an understanding of the leadership role in formal organizations. In R. Dubin, G. Homans, F. C. Mann, & D. Miller (Eds.), Leadership and Productivity. San Francisco: Chandler, 1965.

Mann, G. H. A method for measurement of cholesterol in blood serum. Clinical Chemistry, 1961, 7, 275-284.

McClelland, D. C. Methods of measuring human motivation. In J. W. Atkinson (Ed.), Motives in Fantasy, Action, and Society. Princeton: D. Van Nostrand, 1958.

McClelland, D. C., Atkinson, J. W., Clark, R. W., & Lowell, E. L. The Achievement Motive. New York: Appleton-Century-Crofts, 1953.

Mersy, D. J., Auyong, T. K., & Eelkema, R. C. Relationship of serum urate levels to occupation and mental retardation. Psychosomatics, 1968, 9, 199-201.

Mikkelsen, W. M., Dodge, H. J., & Valkenburg, H. A. The distribution of serum uric acid values in a population unselected as to gout or hyperuricemia. Tecumseh, Michigan, 1959-1960. American Journal of Medicine, 1965, 39, 242-251.

Montoye, H. J., Faulkner, J. A., Dodge, H. J., Mikkelsen, W. M., Willis, P. W., III, & Block, W. D. Serum uric acid concentration among business executives. Annals of Internal Medicine, 1967, 66, 838-850.

Moore, C. B., & Weiss, T. E. Uric acid metabolism and myocardial infarction. In T. N. James, & J. W. Keyes (Eds.), The Etiology of Myocardial Infarction. Boston: Little, Brown, 1963.

Moruzzi, G., & Magoun, H. W. Brain stem reticular formation and activation of the EEG. EEG and Clinical Neurophysiology, 1949, 1, 455-473.

Moses, C. Atherosclerosis. Philadelphia: Lea & Febiger, 1963.

Moulton, R. W. Notes for a projective measure of fear of failure. In J. W. Atkinson (Ed.), Motives in Fantasy, Action, and Society. Princeton: D. Van Nostrand, 1958.

Mueller, E. F., & Beimann, M. Die beziehung der harnsäure zu testwerten der nach Heckhausen gemessenen leistungsmotivation. Zeitschrift für Experimentelle und Angewandte Psychologie, 1969, Brand XVI, Heft 2, S. 295-306.

Mueller, E. F., Kasl, S. V., Brooks, G. W., & Cobb, S. Psychosocial correlates of serum urate level. Psychological Bulletin, 1970, 73, 238-257.

Murphy, R., & Shipman, K. H. Hyperuricemia during total fasting. Archives of Internal Medicine, 1963, 112, 954-959.

Myers, A. R., Epstein, F. H., Dodge, H. J., & Mikkelsen, W. M. The relationship of serum uric acid to risk factors in coronary heart disease. American Journal of Medicine, 1968, 45, 520-528.

Neel, J. V., Rakic, M. T., Davidson, R. T., Valkenburg, H. A., & Mikkelsen, W. M. Studies on hyperuricemia. II. A reconsideration of the serum uric acid values in the families of Smyth, Cotterman and Freyburg. American Journal of Human Genetics, 1965, 17, 14-22.

Nichols, F., Miller, A. T., & Hiatt, E. P. Influence of muscular exercise on uric acid excretion in man. Journal of Applied Physiology, 1950-1951, 3, 501-507.

Nugent, C. A., & Tyler, F. H. The renal excretion of uric acid in patients with gout and in nongouty subjects. Journal of Clinical Investigation, 1959, 38, 1890-1898.

Nyhan, W. L., Oliver, W. J., & Lesch, M. A familial disorder of uric acid metabolism and central nervous system function. II. Journal of Pediatrics, 1965, 67, 257-263.

Oberman, A., Lane, N. E., Mitchell, R. E., & Graybiel, A. The Thousand Aviator Study: Distributions and Intercorrelations of Selected Variables. United States Naval Aerospace Medical Institute, Pensacola, Florida, 1965, No. 12.

O'Brien, W. M., Burch, T. A., & Bunim, J. J. Genetics of hyperuricemia in Blackfeet and Pima Indians. Annals of Rheumatic Diseases, 1966, 25, 117-119.

Ogryzlo, M. A. Hyperuricemia induced by high fat diets and starvation. Arthritis and Rheumatism, 1965, 8, 799-818.

Orowan, E. Origins of man. Nature, 1955, 175, 683-684.

Oser, B. L. (Ed.) Hawk's Physiologic Chemistry. New York: McGraw-Hill, 1965.

O'Sullivan, J. B. The incidence of gout and related uric acid levels in Sudbury, Massachusetts. In P. H. Bennett, & P. H. N. Wood (Eds.), Population Studies of the Rheumatic Diseases. New York: Excerpta Medica Foundation, 1968. (a)

O'Sullivan, J. B. The contributions of technical variation to uric acid levels. In P. H. Bennett and P. H. N. Wood (Eds.), Population Studies of the Rheumatic Diseases. New York: Excerpta Medica Foundation, 1968. (b)

Pelz, D. C., & Andrews, F. M. Scientists in Organization: Productive Climates for Research and Development. New York: Wiley, 1966.

Pfeiffer, C. C., & Illiev, V. Alterations in the quantitative EEG and in serum uric acid after administration of nicotinamide adenine dinucleotide precursors. Federation Proceedings, 1967, 26, 323.

Popert, A. J., & Hewitt, J. V. Gout and hyperuricemia in rural and urban populations. Annals of the Rheumatic Diseases, 1962, 21, 154-163.

Prior, I. A. M., & Rose, B. S. Uric acid, gout and public health in the South Pacific. New Zealand Medical Journal, 1966, 65, 295-300.

Prior, I. A. M., Rose, B. S., Harvery, H. P. B., & Davidson, F. Hyperuricemia, gout and diabetic abnormality in Polynesian people. Lancet, 1966, 1, 333-338.

Rahe, R. H., & Arthur, R. J. Stressful underwater demolition training. Serum urate and cholesterol variability. Journal of the American Medical Association, 1967, 202, 1052-1054.

Rahe, R. H., Rubin, R. T., Arthur, R. J., & Clark, B. R. Serum uric acid and cholesterol variability. Journal of the American Medical Association, 1968, 206, 2875-2880.

Reichenbach, H. The logical foundations of the concept of probability. In H. Figel, & M. Brodbeck (Eds.), Readings in the Philosophy of Science. New York: Appleton-Century-Crofts, 1953.

Rodnan, G. P. Gallery of gout. Arthritis and Rheumatism, 1961, 4, 27-46. (a)

Rodnan, G. P. Gallery of gout. Arthritis and Rheumatism, 1961, 4, 176-194. (b)

Rodnan, G. P. Early theories concerning etiology and pathogenesis of gout. Arthritis and Rheumatism, 1965, 8, 599-609.

Rosen, B. C. The achievement syndrome. American Sociological Review, 1955, 21, 185-218.

Rosenman, R. H., & Friedman, M. Behavior patterns, blood lipids and coronary heart disease. Journal of the American Medical Association, 1963, 184, 934-938.

Rubin, R. T., Plag, J. A., Arthur, R. J., Clark, B. R., & Rahe, R. H. Serum uric acid: Diurnal and hebdomadal variability in normoactive subjects. Journal of the American Medical Association, 1969, 208, 1184-1186.

Rundle, A. T., & Fannin, C. V. A survey of serum uric acid levels in mentally retarded patients. Journal of Mental Deficiency Research, 1966, 10, 282-286.

Rundles, R. W., Elion, G. B., & Hitchings, G. H. Allopurinol in the treatment of gout and secondary hyperuricemia. Bulletin on Rheumatic Diseases, 1966, 16, 400-403.

Ryckewaert, A., Dry, J., Kuntz, D., & Paolaggi, F. Les hyperuricemies. VII. Les substances hyperuricemintes. Revue du Rhumatisme aet des Maladis Osteo-Articularies, 1967, 34, 209-213.

Sales, S. M. Differences among individuals in affective, behavioral, biochemical, and physiological responses to variations in work load. Unpublished doctoral dissertation, University of Michigan, 1969.

Sampson, E. E. Birth order, need achievement, and conformity. Journal of Abnormal and Social Psychology, 1962, 64, 155-159.

Schachter, S. Birth order, eminence and higher education. Sociological Review, 1963, 28, 757-767.

Schonpflug, W. Aktivierung, leistung und zielgerichtetes verhalten. In F. Merz (Ed.), Bericht ueber den 25. Kongress der Deutschen Gesellschaft fuer Psychologie Munster 1966. Goettingen: Hogrefe, 1967.

Scott, J. T., McCallum, F. M., & Holloway, V. P. Starvation, ketosis and uric acid excretion. Clinical Sciences, 1964, 27, 209-221.

Seegmiller, J. E. The study of human intermediary purine metabolism and its regulation. Proceedings of the Royal Society of Medicine, 1966, 59, 292-302.

Seegmiller, J. E., Rosenbloom, F. M., & Kelley, W. N. Enzyme defect associated with a sex-linked human neurological disorder and excessive purine synthesis. Science, 1967, 155, 1682-1684.

Shapiro, J. R., Klinenberg, J. R., Peck, W., Goldfinger, S. B., & Seegmiller, J. E. Hyperuricemia associated with obesity and intensified by caloric restriction. Arthritis and Rheumatism, 1964, 7, 343.

Smyth, C. J. Discussion comment. In F. E. Demartini, Hyperuricemia induced by drugs. Arthritis and Rheumatism, 1965, 8, 829.

Smyth, C. J. Hereditary factors in gout. A review of recent literature. Metabolism, 1957, 6, 218-229.

Smyth, C. J., Cotterman, C. W., & Freyberg, R. H. The genetics of gout and hyperuricemia--an analysis of 19 families. Journal of Clinical Investigation, 1948, 27, 749-759.

Stanbury, J. B., Wyngaarden, J. B., & Frederickson, D. S. (Eds.) The Metabolic Basis of Inherited Disease. New York: McGraw-Hill, 1966.

Stecher, R. M., Hersh, A. H., & Solomon, W. M. The heredity of gout and its relationship to familial hyperuricemia. Annals of Internal Medicine, 1949, 31, 595-614.

Stetten, de W., & Hearon, J. E. Intellectual level measured by Army classification battery and serum uric acid concentration. Science, 1959, 129, 1737.

Talbott, J. H. Gout. New York: Grune & Stratton, 1967.

Taylor, J. A. A personality scale of manifest anxiety. Journal of Abnormal and Social Psychology, 1953, 48, 285-290.

Technicon Auto-Analyzer Methodology. Chauncey, N. Y.: Technicon Laboratories Research Park, 1965.

Veroff, J., Atkinson, J. W., Feld, S. C., & Gurin, G. The use of thematic apperception to assess motivation in a national interview study. Psychological Monographs, 1960, 74, 1-32.

Vogel, W., Broverman, D., Draguns, J. G., & Klaiber, E. L. The role of glutamic acid in cognitive behavior. *Psychological Bulletin*, 1966, *65*, 367-382.

Wolfson, W. Q., Krevsky, D., Levine, R., Kadota, K., & Cohn, C. Endocrine factors in gout: The significance of differences in childhood and adult urate metabolism. *Journal of Clinical Endocrinology*, 1949, *9*, 666-667.

Yü, T. F., Berger, L., & Gutman, A. B. Renal function in gout: II. Effect of uric acid loading on renal excretion of uric acid. *American Journal of Medicine*, 1962, *33*, 829-840.

Yü, T. F., & Gutman, A. B. Quantitative analysis of uric acid in blood and urine. Methods and interpretation. *Bulletin on Rheumatic Diseases*, 1957, 7(Suppl. S17-S20).

Yü, T. F., & Gutman, A. B. A study of the paradoxical effects of salicylate in low, intermediate and high dosage on the renal mechanisms for excretion of urate in man. *Journal of Clinical Investigation*, 1959, *38*, 1298-1315.

Yü, T. F., Sirota, J. H., Berger, L., Halpern, M., & Gutman, A. B. Effect of lactate infusion on urate clearance in man. *Proceedings of the Society on Experimental Biological Medicine*, 1957, *96*, 809-813.

Zachau-Christiansen, B. The variation in serum uric acid during 24 hours and from day to day. *Scandinavian Journal of Clinical and Laboratory Investigations*, 1957, *9*, 244-248.

Zachau-Christiansen, B. The rise in the serum uric acid during muscular exercise. *Scandinavian Journal of Clinical and Laboratory Investigations*, 1959, *11*, 57-60.

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